ois IS& Mapnotes

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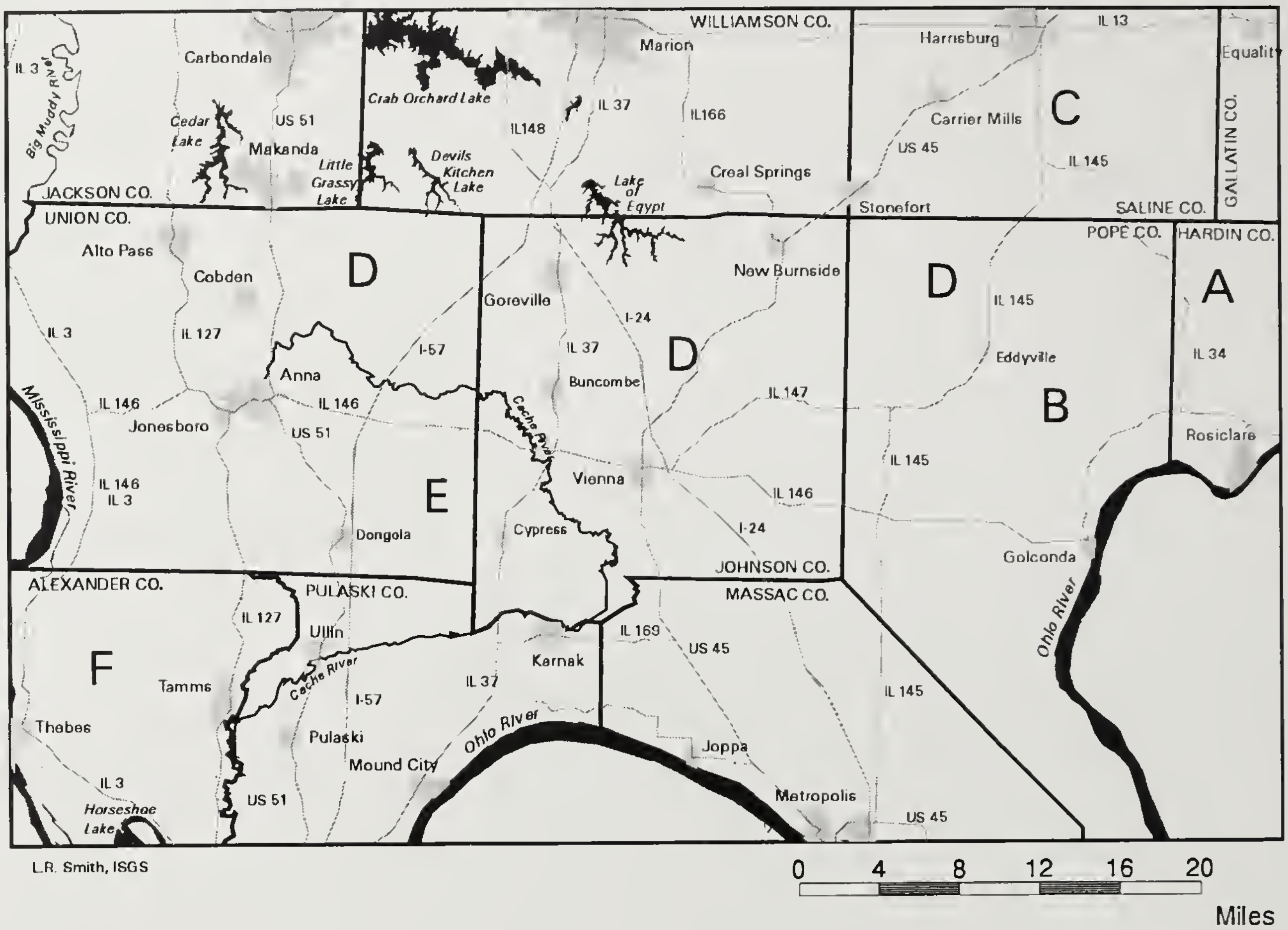

Shaded Relief Map of Southern Illinois

The image portrayed on the cover is referred to as a shaded relief map and was produced by processing all or portions of 48 U.S. Geological Survey 7.5-minute digital elevation models (DEM). Elevation information is characterized by contour lines on USGS quadrangle maps, but contours do not provide an effective means of graphically portraying surface topography. After mosaicking, a specialized algorithm was used to process the DEM information so that the terrain appears to be illuminated from the northeast at a low sun angle. All streams and water features have been derived from two databases: the USGS 1:100,000-scale Hydrography and the Land Cover of Illinois. The scale of the shaded relief map is approximately 1 inch = 3.7 miles (RF 1:235,000).

The distinctive oval-shaped feature near the right margin of the front cover (A) is Hicks Dome, a cryptoexplosion structure, situated in the eastern half of the Shawnee Hills of southern Illinois. At the surface, the dome and the surrounding concentric cuesta are composed of strata from the middle Paleozoic (320-380 million years before the present [MYBP]). Prominent northeast-to-southwest trending lineaments (B) are mostly high-angle faults of late Paleozoic-age (245-300 MYBP).

Characterized by extensive flat areas, the southern limit of Pleistocene glaciation (10,000 YBP-1.6 MYBP) forms the margin of the Shawnee Hills along the upper portion of this shaded relief map. The broad, flat areas at C are mostly Pleistocene lake deposits that formed in slack water as glacial meltwaters flowed down the Wabash River valley located just to the east.

Within the Shawnee Hills, in the northern and particularly western part of the shaded relief map, Pennsylvanian-age (290-320 MYBP) clastic strata comprise both more rugged topography and usually higher elevations (D). The southern portion of the shaded relief map is typified by less rugged, Mississippian-age (320-360 MYBP) limestone-dominated strata, which often form broad cuestas (back cover, E). The western edge of the Shawnee Hills, including the boot heel between the Mississippi and Cache River valleys (back cover F), is composed mostly of rugged Silurian (410-440 MYBP) and Devonian-age (360-410 MYBP) cherts and limestones.

The Cache River valley, which extends across the bottom of the shaded relief map as a broad, sinuous lowland, is filled with Pleistocene alluvial and lake deposits. This lowland demarcates the path of the ancestral Ohio River before the diversion to its present course approximately 20,000 YBP. The gentle surface topography situated between the Cache River lowland and the Ohio River valley is comprised mostly of Cretaceous (66-144 MYBP) and Tertiary-age (1.6-66 MYBP) coastal plain sediments of the Mississippian Embayment.

Donald E. Luman, C. Pius Weibel, Lisa R. Smith
Illinois State Geological Survey

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Editorial Offices
Illinois GIS Association
Center for Governmental Studies
Northern Illinois University
DeKalb, Illinois 60115

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Editor
Donald E. Luman
Illinois State Geological Survey

Layout and Graphics
Kathleen Shankman
Center for Governmental Studies
Northern Illinois University

Editor's Note

The 1997 issue of *Illinois GIS & Mapnotes* is dedicated to Richard E. Dahlberg. Dick created it and was its editor for 16 years. Since 1981, the publication has evolved from focusing on a wide range of mapping issues throughout the 1980s to addressing rapidly emerging technologies during the 1990s. Dick was very knowledgeable about the trends in cartography and geographic information systems, and he revised the name of the publication from *Illinois Mapnotes* to *Illinois GIS & Mapnotes* in 1989 to better reflect these changes. Today, *Illinois GIS & Mapnotes* remains a unique source of up-to-date news and applications for a wide range of Illinois users of cartographic and geographic information.

Richard E. Dahlberg
1928 – 1996

Tribute to Richard E. Dahlberg

Originally presented at the Illinois Mapping Advisory Committee Meeting, April 15, 1997, Champaign, Illinois

Jon M. Leverenz
Executive Editor
Rand McNally
Skokie, Illinois

Thank you very much for asking me to reflect on the work of Richard E. Dahlberg. It is a real honor for me to be able to pay tribute to Dick because he was a dear friend to me, and to you, and the best friend that our related professions have ever had.

After reviewing the body of work of this great man, I realized that it would be impossible to do him justice in a short period of time. And because Dick's work cut across all boundaries, it is difficult to separate his work and to talk only about his contributions to the "private sector" of cartography, as I was asked to do. So, this afternoon I will touch on a few aspects of his career with which I am personally familiar. You will note that my reflections are not so much about *what* he did (as important as that is) but about *how* he went about contributing so much to our profession throughout his life.

What will be said will probably not be new to you because you all were aware of the wonderful qualities that defined Dick. However, some items may come out that add to our understanding of him and that help us get a better idea of the full measure of the man. In so doing, we might better honor his memory and also understand how we might best contribute to and continue with the work in which we were mutually engaged.

Dick had a marvelous perspective on the universe and a grasp on how things fit together, both big and small. His approach was one of *outreach* and *ingathering,* which was rooted in his understanding of mankind and God and where we all stood in the universe.

When the cartographic community tended to compartmentalize itself, Dick was there gently showing us how well we all fit together. His studies and work on the manpower needs of the whole mapping community came early (in the 1970s and 1980s) and set the stage for his early recognition, endorsement, and promotion of GIS — an approach that brought together the potential of all the people in the related sciences that describe, measure, monitor, and portray the Earth.

Dick was interested in the macro *and* the micro of cartography, and nothing really escaped him. His interest in relating the seemingly unrelated was always impressive. This stemmed from his ability to assimilate a tremendous amount of information, "internalize" it, as he would say (that is, boil it down and fit it into his ever-expanding and changing knowledge base), and then present that information in a clear, logical, organized, and practical manner to us.

Dick questioned as one wanting to know more — for the sake of knowing, and for our sake. Not to impress with his insights, but to seek the answer to the questions so he could help in the solution of a problem. Every discussion I had with him was characterized by his open and calm manner and the belief that all information was important — and all thoughts that were given to him were taken seriously.

I will always remember one of my first conversations with Dick in laying out a project. I said that this project has its simple and its complex parts — I am simple and the project is complex. I think he realized that, but he was ever the gentleman in leading me through the complexities and making them clear. He was a true scholar — and a gentleman.

Dick's activities in the Ameri-

can Congress on Surveying and Mapping are particularly memorable to me because it was at those meetings that we did most of our talking. We used to share rooms at the spring and fall meetings. That solidified our friendship — and it also helped with our meager *per diem* stipends. Dick would always bring me up to date on the happenings in the broader cartographic community, and we would try to make sense of the politics that often prevailed. It was in those early meetings of the 1970s that I was introduced to a *Dahlbergism* that characterized his method of communication and probably his means of storage and recall. Dick used a tremendous number of acronyms — you might be familiar with that. There were the familiar — ACSM, USGS, AAG, DOT, IDOT, ICA, IAC — that we all know. But then there were those that were pure *Dahlberg.* I always had to stop him and make him clarify the many that proliferated in our discussions.

The last pure *Dahlbergism* I remember him using was during a discussion in which he was critiquing poorly created digital maps. He concluded by saying that "there are too many people out there with personal computers producing MLOs." Of course, I had to ask him what an MLO was, and he looked at me as if I were the only one who didn't know, as he would do on those occasions, and said, "map-like objects." I think he took quiet delight in my having to ask him what that meant. Maybe it was a way to test if I was interested.

His notes were full of these abbreviations, which I am sure only he knew. And speaking of notes, Richard Dahlberg's notes were meticulous and organized, and as I mentioned before, nothing escaped him. After a discussion he would always review those carefully crafted words and clarify items that needed clarification for him. I am sure his students benefited from the lectures he gave because of his notes. Another legacy of his.

It was at the ACSM meetings, and through that organization as well as the American Society of Photogrammetry, and all the other national, state, and regional organizations he was associated with that Dick was able to reach into the U.S. cartographic community and bring some unity and understanding — more than any other person I know. He did so, not only as the president of ACSM and in his leadership roles elsewhere, but also as editor of *Cartography and Geographic Information Systems (C&GIS),* and in valuable contributions on committees — especially the Education Committees of ACSM and of the International Cartographic Association. His 21 years of work on the Illinois Mapping Advisory Committee is legend, as is his creation and development of the publication, *Illinois GIS & Mapnotes.*

With his teaching at Syracuse University and Northern Illinois University, the prodigious amount of research and publishing, and his leadership roles in a host of state, national, and international organizations, it is hard to imagine that Dick was able to work in the private, "commercial," sector at all. But that he did, and welcomed the opportunity to extend his knowledge and contribute on a broader scale. He was such a hard worker.

I will mention only a few of Dick's contributions to the private sector with which I am familiar, just to give us further insights into the breadth and scope of this man and to indicate how he used his skills and approach to solve cartographic problems no matter where they occurred.

The first time I saw the printed name of Richard E. Dahlberg was in conjunction with a private commercial enterprise. It was the *Prentice Hall World Atlas* published in the late 1950s and early 1960s. He was the editor of the publication, which had its origins in Europe. The excellence that marked his whole career can still be witnessed by examining a copy of that publication. It reached many students as the atlas of choice in the early 1960s.

In the 1970s Dick served as the editor for John Wiley and Sons on the development of another school atlas. His work on that took him to Vienna where he worked with European cartographers in structuring the book. Unfortunately, that atlas was never published. We talked a lot in that period, and though setbacks of this nature were frustrating for Dick, he was

undaunted and used the experience to continue his research into users' perceptions of thematic maps, among other things. So, instead of moving away from the topic, he approached it from a different way in order to increase our knowledge while increasing his. That whole period of Dick's involvement with other firms was disappointing for me because we at Rand McNally were searching for an associate editor for *Goode's World Atlas* and an advisor. Dick, the number one choice, was not available because of his activities elsewhere.

In the early 1980s, however, we were finally able to entice Dick to help Rand McNally. Since that time he worked on a number of projects for us. Early on we needed help creating street maps of large cities using vertical and oblique aerial photography. Dick's research and practical experiments at that time aided us in developing a visually pleasing way of melding the image with the map type and symbols needed to make a useful, readable photomap.

As you all know, the Laboratory for Cartography and Spatial Analysis at Northern Illinois University was Dahlberg's doing. He conceived of it, he developed it, and he made it a force in creating useful and practical maps, especially for the counties and cities of northern Illinois, as well as for the state. With it he helped to make this part of the Midwest the "center of the cartographic mass." Or, as he would say, "the COCM." Through the lab, Dick ran practical experiments on symbolization and color and tested his concepts of map making that benefited the commercial sector as well as other sectors. However, he always accepted only that work which would instruct students and add something special to their training. The lab was not to compete with the private sector, and it never has.

I do not know of all the projects Dick and his staff created, but all the projects I know of benefited from his sharp eye for completeness, accuracy, and usefulness, as well as his administrative skill in assembling, training, and keeping talented people. One such project that the lab produced is the set of bicycle maps of Illinois.

In the late 1980s and early 1990s Dick and his staff developed a series of world thematic maps for Rand McNally and helped in a number of digitally created maps for children's atlases. The last project Dick helped us with was to serve as general consultant for cartographic development. His initial report of 1996 was to be the first of many that we expected would help us create useful, handsome, and saleable products into the 21st century. We will miss his unique input.

Dick's outreach and ingathering had a worldwide scope, and the many international students that he introduced to me throughout our association were only a sample of this part of his broad influence. He was active in the International Cartographic Association for years and delivered numerous papers and served on a number of panels and committees. Fittingly, the ICA recognized his experience and abilities and made him a part of a select international team that taught cartography in China a few short years ago.

Complete justice to Richard E. Dahlberg's legacy would take all of us, and many more, months of constant reading and hours of discussion in which to compare our individual experiences with him and his work. Even then we would come up short. Fortunately, that really isn't necessary because Dick was always aware of what he was doing and did not need people to praise his every move. Simply put, he was seeking knowledge and he was sharing knowledge freely in every endeavor to reach important goals. That was enough for Dick — and that is one of the most important things to remember about him. Everything he did was important, no sifting or winnowing needed.

His lifelong accomplishments — notably, his students and his body of work — give us tangible items to reflect and build upon. But Dick also gave to us his marvelous way of getting things done — his outreach and ingathering approach. This approach that incorporated all of our ideas in a kind, respectful, open, truthful, and fair manner — with a lot of work and intellect on his part — guided us for the purpose of knowing more, doing more, and doing it better.

In Memory of Richard E. Dahlberg

Richard E. Vaupel
Laboratory for Cartography and Spatial Analysis
Department of Geography
Northern Illinois University
DeKalb, Illinois

Rich and Dick conferring on a project at the NIU Laboratory for Cartography and Spatial Analysis (from color insert)

Editor's Note

The color insert accompanying this issue of *Illinois GIS & Mapnotes* is presented as a gift to *Mapnotes* readers by Mrs. Pat Dahlberg, Dick's wife, and Mr. Richard Vaupel, Dick's longtime colleague. If you would like additional, unfolded copies of this color insert, please contact Chris Welch at the Center for Governmental Studies, 815.753.1906.

Principal Paper

GIS Environment for Simulation and Analysis of Landscape Processes

Helena Mitasova
Geographic Modeling Systems Laboratory, Department of Geography University of Illinois-Urbana, Urbana, Illinois

William M. Brown
Geographic Modeling Systems Laboratory, Department of Geography University of Illinois-Urbana, Urbana, Illinois

Lubos Mitas
National Center for Supercomputing Applications University of Illinois-Urbana, Urbana, Illinois

Steven Warren
U.S. Army Construction Engineering Research Laboratories Champaign, Illinois

Introduction

Efforts to balance economic development and environmental protection require new strategies for land use management based on better understanding of human impacts on landscape processes. Recent advances in the development of GIS technology, and in the availability of high resolution spatio-temporal data as well as exponential growth in computational power create conditions for building *numerical simulation laboratories.* In combination with field experiments, these laboratories can significantly enhance our understanding of landscapes as complex systems. To support the simulation and analysis of landscape processes, we have been developing methods, algorithms, and software tools that extend the capabilities of GIS beyond automatic mapping and that provide an environment for processing, analyzing, and communicating complex landscape phenomena in 3D space and time. Our methodological framework builds upon and extends our previous work (Mitasova et al. 1995a, Mitas et al., 1997), which is based on the *representation of phenomena by multivariate functions* (scalar or vector fields), and on the *description of landscape processes by first principles equations* which determine the configuration or evolution of corresponding fields.

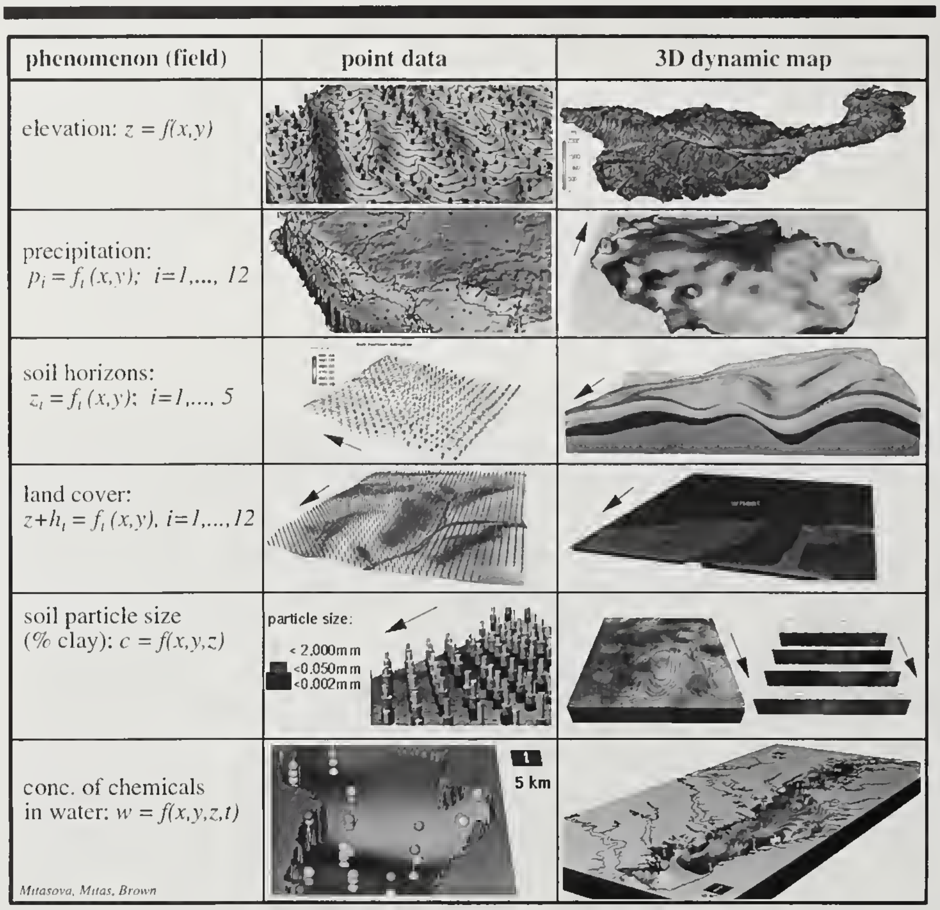
In this paper we discuss some of the issues related to the application of GIS for landscape characterization and simulation, in particular, spatial interpolation and visualization, and their role in the development and communication of complex spatial models.

Spatial Interpolation and Topographic Analysis

Most inputs for distributed models of landscape processes are given by functions that depend on the position in 3D space and time. These *multivariate scalar and vector fields* represent quantities such as terrain, rainfall, temperatures, physical properties of soils, land cover, fluxes of matter, etc. While most of the field measurements are performed at sampling sites, often irregularly distributed in space and time, visualization, analysis and modeling within a GIS are often based on a raster representation (Figure 1). Reliable interpolation tools are therefore needed to support the preprocessing of data for landscape simulations. The underlying methods must satisfy several important demands: accuracy and predictive power, robustness and flexibility in describing various types of phenomena, smoothing for noisy data, d-dimensional formulation, direct estimation of derivatives (gradients, curvatures), applicability to large data sets, computational efficiency, and ease of use.

Currently it is difficult to find a method that fulfills all of these requirements for a wide range of

Figure 1
Landscape characterization by sampling points and multivariate fields represented by 2D, 3D, and 4D rasters



georeferenced data. Therefore, selecting an adequate method with appropriate parameters for a particular application is crucial. Different methods can produce quite different spatial representations (Figure 2), and in-depth knowledge of the phenomenon is needed to evaluate which one is the closest to reality. Unsuitable methods or inappropriate parameters can result in a distorted model of spatial distribution, leading to potentially wrong decisions based on misleading spatial information. An inappropriate interpolation can have even more profound an impact if the result is used as an input for simulations, where a small error or distortion can cause models to produce false spatial patterns (Mitas and Mitasova, in press).

Over the last few years we have developed a multivariate interpolation method (Mitas and Mitasova, 1988; Mitasova and Mitas, 1993; Mitasova et al., 1995a), which proved to be a valuable tool supporting the processing of data for creating spatio-temporal models of landscape phenomena and for preparing inputs for process-based landscape simulations. The method is called *Regularized Spline with Tension* (RST) and has been implemented within the GRASS GIS since 1993 *(s.surf.tps, s.surf.rst)*, with regular updates and enhancements. The older, less general and also less robust version of the spline interpolation function published by Mitas and Mitasova (1988), has been implemented in ArcGrid and ArcView Spatial Analyst. Although the current implementation has several problems, after appropriate fixes it may become a useful alternative to other interpolation methods available to ArcGrid and ArcView users. RST is based on the minimization of a smoothness functional with variational parameters such as an anisotropic tension. These can be used to change the character of the interpolant to properly represent the behavior of modeled phenomenon. The variational capabilities of the RST were very useful in our effort to produce high-quality digital terrain models, where we were able to eliminate many artificial features typical of numerous interpolation methods currently available (Mitasova et al., 1996; Mitasova et al., 1995a; Wood and Fisher, 1993). These artificial features, especially the waves along contours (Mitasova et al., 1996; Mitas and Mitasova, in press), or the peaks and pits around the data points (Figure 2, IDW, Kriging, Topogrid), make the use of standard interpolation methods problematic, especially for producing inputs for some highly sensitive models of landscape processes.

Because the RST method has a *d*-dimensional formulation (Mitasova et al., 1995a) it was implemented also as a volume and volume-time interpolation function for computation of 3D and 4D models of landscape phenomena measured in 3D space and time, such as the concentration of chemicals or soil properties. Because the landscape characterization data

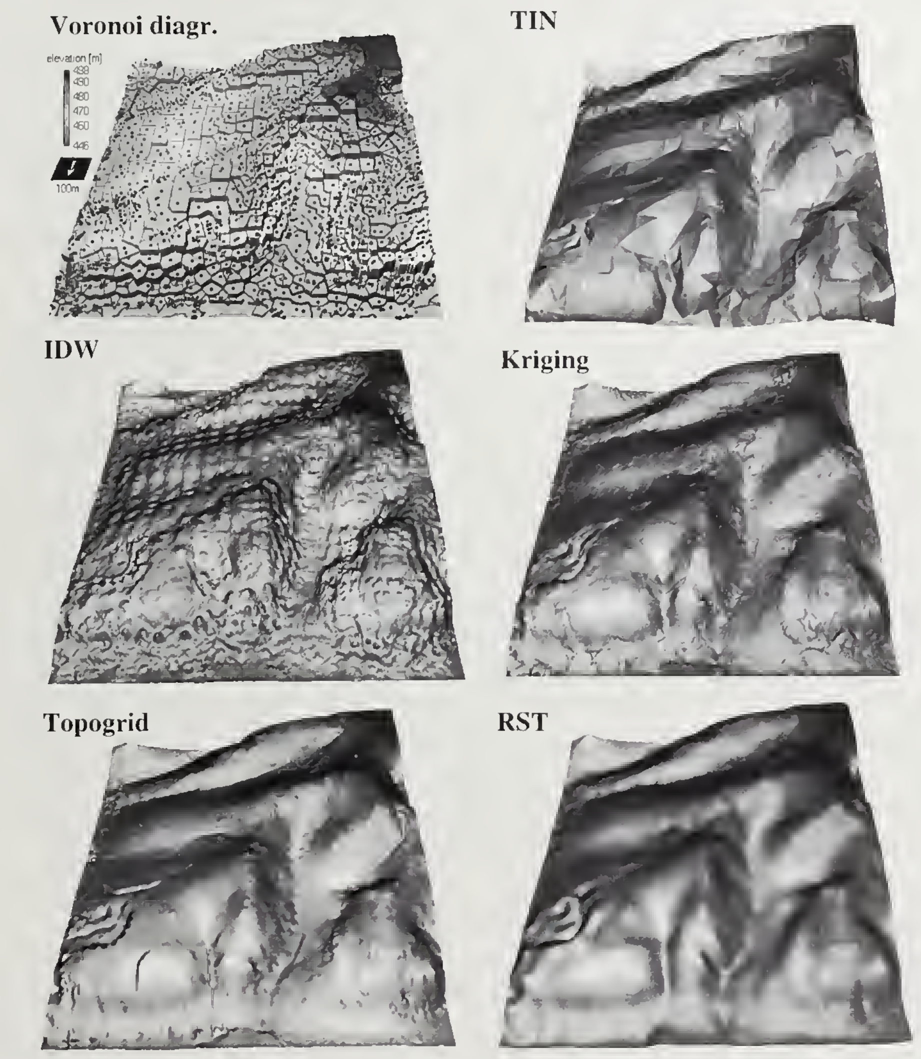


Figure 2
Spatial interpolation of a DEM with methods common in GIS

have different properties and distributions in horizontal/vertical/temporal dimensions, anisotropic tension or rescaling is used in vertical and temporal directions to ensure the numerical stability of interpolation.

To gradually fulfill the requirements of spatial interpolation for GIS applications, we are periodically improving the implementation of the RST method with the most recent enhancements including the support for spatially variable smoothing, which allows users to set a different smoothing parameter for each given point, depending on the accuracy of the measurement. This capability supports the combination of data from various sources with different accuracies. The resulting surfaces pass the closest to the most accurate data and are allowed to deviate more from the data that are measured less accurately.

Besides multivariate interpolation, the RST method was also designed to support the analysis of the geometry of interpolated surfaces and volumes by computation of slope, aspect and different types of curvatures using derivatives of the RST function (Mitasova and Hofierka, 1993; Mitasova et al., 1995a). These parameters are often needed as inputs for landscape process models; therefore, their reliable estimation is crucial for successful simulations. Within our approach the computation of topographic parameters is performed simultaneously with interpolation, leading to increased reliability and consistency in their estimation.

Another class of topographic parameters, such as upslope contributing area or slope length, is based on flow-tracing. We have developed a vector-grid algorithm for relatively fast and simple estimation of these parameters (Mitasova et al., 1996) and implemented it in GRASS GIS as *r.flow*. For more complex applications we have developed a physics-based approach using Monte Carlo solution of water flow continuity equation within an erosion simulation tool SIMWE (Mitas and Mitasova, 1997). The process-based approach helps to resolve some problems of geometry-based approaches, such as dispersal flow, overflowing pits, or split streams.

Visualization

Advanced visualization tools supporting visual analysis and communication of complex 3D spatio-temporal data significantly enhance the efficiency of the development and applications of

landscape process models. While a wide selection of computing platforms and software solutions is available for creating sophisticated dynamic 3D visual models (Raper, 1989; Hibbard et al., 1994; Stephan, 1995), there are still only a few examples of full integration of such visualization capabilities within a single GIS providing seamless sharing of data or object types. Implementation of the landscape simulation concepts described in the introduction has stimulated, indeed demanded, integration of GIS and computer cartography with scientific visualization (Brown and Gerdes, 1992; Brown and Astley, 1995). To provide insight into spatial and spatiotemporal relations of studied phenomena, the cartographic models are created within a GIS, using multiple dynamic surfaces and isosurfaces, together with draped raster, vector, and point data in an appropriate projection of 3D space. Visual exploration and analysis of data are facilitated by interactive manipulations of visualization environment parameters such as viewing position, z-scale, cutting planes for profiles and fence diagrams, light position, and brightness. Dynamic cartographic models are developed by animating the sequences of images created by changing the viewing parameters or by displaying evolving series of data (Brown et al., 1995; Mitas et al., 1997). Interactive query capabilities, whereby original attributes are retrieved directly from the GIS database, facilitate the modeling process. Integration within the GIS encourages greater use of all available data due to the ease of data access and manipulation. Such integration also stimulates an interdisciplinary research involving specialists from various disciplines who use GIS to perform different tasks on the same data sets.

Use of visualization at different stages of the development and analysis of a complex erosion model is described in detail by Mitas et al. (1997), including the animations published on a CD-ROM and the World Wide Web. The animations were used to illustrate the stochastic method of the continuity equation solution, the impact of the change in model parameters on the results, comparison with field data, and computer aided erosion prevention design. The use of dynamic cartographic models for visual analysis of multivariate landscape phenomena characterized by sets of discrete sampling points and by interpolated surfaces/hypersurfaces is also illustrated by the examples in Figure 1.

The efficiency and suitability of visualization tools for exploring multivariate land characterization data are ensured by a high level of interactivity and by a combination of advanced visualization capabilities with the traditional spatial query and analysis functions of a GIS (Brown et al., 1995; Brown and Astley, 1995). In an effort to expand some of the interactive visualization capabilities to users accessing the cartographic models on the World Wide Web, a simple translator of georeferenced raster data to Virtual Reality Modeling Language (VRML) formatted files has been developed. This translator, implemented in the GRASS GIS as a command *p.vrml* (Brown, 1996), can be used to output the models of landscape phenomena stored in a GIS database as VRML formatted files, enabling sharing of surface visualizations on the Web.

Applications

We illustrate the methods we've presented using an example of 3D modeling of soil properties and erosion simulations using the SIMWE model (Mitas and Mitasova, 1997) at an experimental farm.

Volume Modeling of Soil Properties

To test the possibilities of creating 3D models of soil properties within a GIS we computed a series of spatial models from comprehensive soil survey data for an experimental farm at Scheyern, Germany (Auerswald et al., 1996). Soil properties (from data provided through the courtesy of Dr. Auerswald) were measured in 3D space up to 1.2m depth, and they included results of chemical analysis (pH, nitrates, phosphates, potassium, organic matter, etc.), soil texture analysis, and qualitative information for each sample. Using these data, it was possible to derive additional information and parameters such as the depth of colluvial deposits and hydraulic conductivity needed for erosion simulations.

From the point of view of spatial modeling, a special challenge for representation and visualization of soil data was posed by the fact that the vertical spatial vari-

ability requires much higher resolutions than the resolutions used for the representation of phenomena in a horizontal plane. We have investigated two approaches to 3D modeling of the measured soil properties (Brown et al., 1997). The first approach is based on bivariate interpolation of soil properties for each horizon and 3D representation by multiple horizon surfaces with color representing the distribution of modeled soil property (Mitasova et al., 1995b, Brown et al., 1997). The second approach is based on trivariate interpolation of point data to a 3D raster map with 2m horizontal and 0.1m vertical resolution using the RST method (Figure 3) and on volume visualization using isosurfaces, animated cross-sections or fence diagrams. To visualize vertical relationships with sufficient detail, we have used 100 times relative exaggeration of depths for both cases.

The results are illustrated by volume models of organic carbon, hydraulic conductivity, and soil reaction (pH) combined with contours (Figure 3). We have found that if the proper tools are available, the full 3D model is more appropriate than the representation based on multiple surfaces as it incorporates the vertical relationships into interpolation and allows more efficient visual analysis.

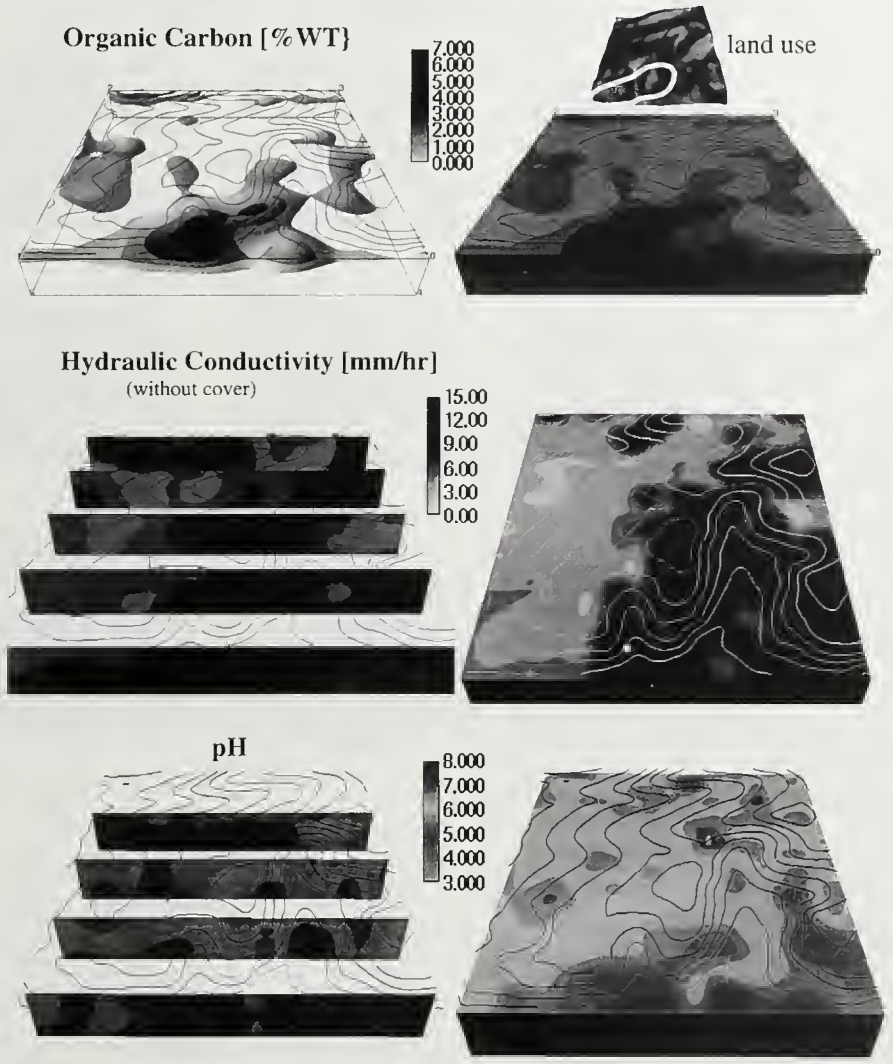


Figure 3
Volume models of soil properties

Distributed Process-Based Erosion Simulations

We illustrate the GIS-supported erosion modeling, using the same study area as in the previous example. As an input for erosion simulations we have interpolated a 2m-resolution DEM from measured elevation data using the RST method and prepared raster maps representing the existing and simulated soil and cover conditions. The simulations were performed by SIMWE, a landscape-scale bivariate model of erosion, sediment transport, and deposition by overland flow designed for spatially complex terrain, soil, and cover conditions (Mitas et al., 1997). The underlying continuity equations are solved by Green's function Monte Carlo method, to provide the robustness necessary for spatially variable conditions and high resolutions. Results of simulations for the traditional land use (Figure 4a) were then compared to data indicating the location of erosion/deposition, in particular, depths of colluvial deposits and linear erosion features digitized from aerial photographs (Mitas and Mitasova, forthcoming).

After proper calibration, the SIMWE model can be used for analyzing and designing the place-

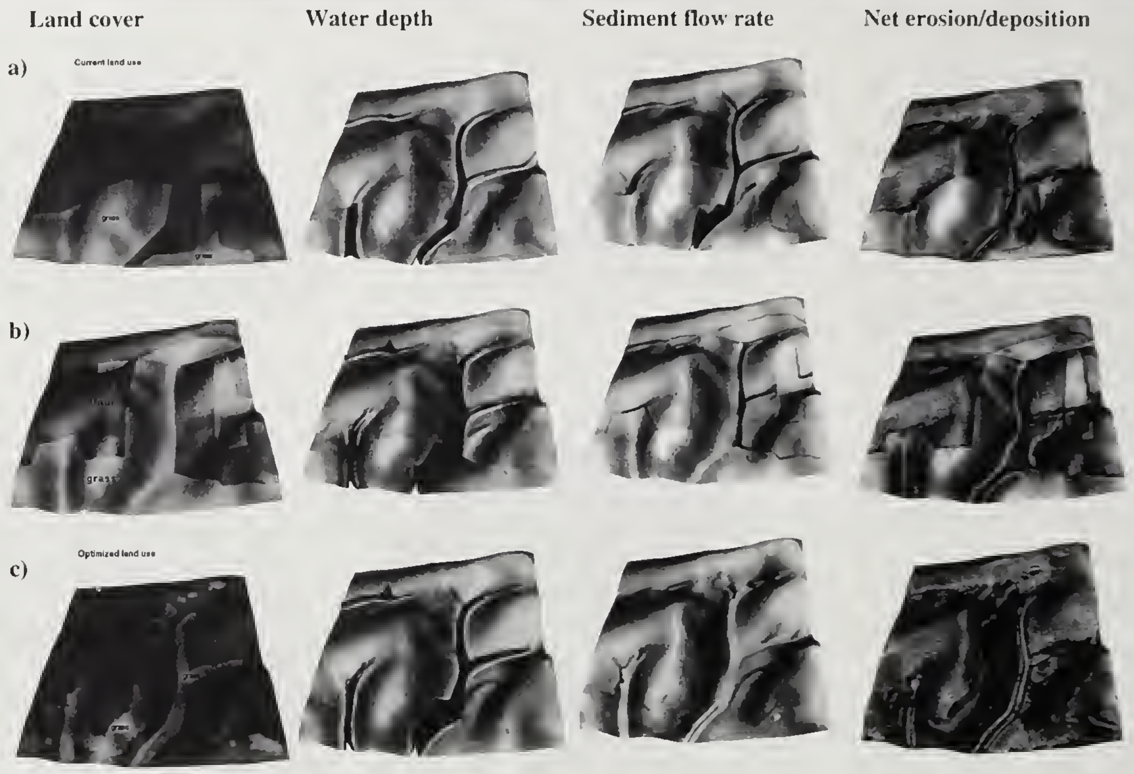


Figure 4
Land use design and simulated water depth, sediment flow and net erosion/deposition.

ment of selected erosion protection measures based on land cover, as illustrated by the following simple example. First, we used the model to identify locations with the highest erosion risk, assuming a uniform land use. Then, the protective grass cover was distributed to the high risk areas while preserving the extent of grass cover at the original 30% of the area (Figures 4a and 4c). We performed a simulation with the new land use to evaluate its effectiveness. The results demonstrate that the new design has a potential to dramatically reduce soil loss and sediment loads in the ephemeral streams when compared with the traditional land use. The crest in sediment flow in the valley disappears and is replaced by light deposition within the grassway, while the maximum and total rates of erosion are significantly reduced. It is interesting to note that the land use design obtained by this rather simple computational procedure, using only the elevation data, had several common features with the sustainable land use design proposed and implemented in 1993 at the farm, based on extensive experimental work (Auerswald et al., 1996). A simplified version of that land use design, along with prediction of water and sediment flows and net erosion/deposition is presented in Figure 4b. It uses a significantly higher proportion of permanent grass cover and fallow leading to higher water depths and further reduction of soil loss. However, there is a higher price paid in the form of reduced agricultural area.

Conclusions

The approach and examples presented in this paper illustrate several aspects of advanced GIS application to landscape characterization and process simulation. Implementation of the multivariate fields concept for landscape characterization in a GIS and development of appropriate tools, such as multivariate RST interpolation and visualization, increase the efficiency of input preparation as well as analysis and presentation of complex simulation results. This approach further supports the move from profile and/or polygon-based models, to more realistic 3D dynamic simulations based on multivariate fields and description of processes by first principles equations.

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Biographies

Helena Mitasova, Ph.D., worked as a Research Scientist at the Department of Physical Geography and Cartography at Comenius University, Bratislava, before coming to the Illinois Natural History Survey as a visiting researcher in 1990. From 1991 to 1995 she was involved in the development of software for surface modeling, analysis, and visualization for GRASS GIS at the U.S. Army Construction Engineering Research Laboratories in Champaign, Illinois. Currently, she is a research associate in the Department of Geography, Geographic Modeling and Systems Laboratory, working on erosion simulations and 3D dynamic GIS.

Lubos Mitas, Ph.D., came to the Department of Physics at the University of Illinois at Urbana-Champaign in 1990 from the Institute of Physics in Bratislava, Czechoslovakia. Since 1992 he has been working at the National Center for Supercomputing Applications as a Research Scientist on quantum Monte Carlo methods for electronic structure of molecules and solids. In addition to his work in physics he has been developing the interpolation methods for geoscientific applications since 1985. Recently, he has developed methods and programs for process-based erosion simulations. His interpolation methods have been implemented in several commercial and public-domain GISs, such as GRASS, ArcGrid, and ArcView.

William M. Brown graduated from the University of Illinois, Urbana-Champaign in 1981 with a B.S. in biology and received an A.A.S. in Visualization Computer Graphics from Parkland College, Champaign, in 1992. He completed an internship at the National Center for Supercomputing Applications in 1991. He worked as a research programmer for the Modeling and Visualization Group, Spatial Analysis and Systems Team, at the U.S. Army Construction Engineering Research Laboratories from 1991 to 1995. Currently he is in the Department of Geography, Geographic Modeling and Systems Laboratory, working on multidimensional dynamic visualization for GIS.

Lubos Mitas (standing), William Brown (center), Helena Mitasova (right)

Steven Warren received his Ph.D. in Watershed Management from Texas A&M University in 1985. Since then, he has worked at the U.S. Army Construction Engineering Research Laboratories in Champaign, Illinois, where he is currently a Principal Investigator in the Resource Mitigation and Protection Division. Dr. Warren assisted in the development of the U.S. Army's Land Condition-Trend Analysis program. As part of that effort, he integrated the Universal Soil Loss Equation with satellite imagery, ground-truthed data, and the Geographical Resources Analysis Support System to produce an erosion-based land capability classification system. Dr. Warren continues to work in the area of soil erosion modeling and prediction, but has expanded his efforts to include research into rehabilitation of severely damaged military training lands. This work includes an investigation into the biology and function of cryptogamic soil crusts as they relate to soil stability in arid and semiarid regions. Dr. Warren is a Certified Professional Soil Erosion and Sediment Control Specialist and a member of the Soil and Water Conservation Society.

Steven Warren

Invited Papers

Dynamic Landscape Simulation in Your Future

Jim Westervelt
Geographic Modeling Systems Laboratory
U.S. Army Construction Engineering Research Laboratories
Champaign, Illinois

Steven J. Harper
Geographic Modeling Systems Laboratory
U.S. Army Construction Engineering Research Laboratories
Champaign, Illinois

Face it! Admit it! The reason you peer into the crystal screen of your geographic information systems is to see and predict the future. It is to help you argue more persuasively what the consequences of alternative land management plans might be. As a professional who uses GIS technologies, you understand this fundamental truth of GIS: It is the essential tool of modern-day land management prophets. Some of you have more than mastered the magical power of the GIS and are more than ready to look even more clearly and more deeply into the future.

There are two classes of ingredients to the modern-day alchemist's recipes for future gazing, and modern GIS technology has powerful tools for dealing with only one of those classes. Current commercial GIS software allows you to capture and analyze traditional maps into digital GIS formats. Image processing packages let you spatially and spectrally analyze imagery captured at almost any altitude. Data collected on the ground by field scientists or their instruments are similarly digitized into our GIS. Once the data are in a digital format, you combine and analyze them using hundreds of incantations — often mixed together into powerful recipes. The best of these are captured as macros and stored in your digital notebooks. Most of us completely ignore, however, the second class of ingredients.

Well, we don't actually ignore this class — we just retain it informally and implicitly in our minds. It consists of our understandings of how the landscape, captured so nicely as data snapshots, actually changes over time — the dynamics. How does that system work? What are the rules and laws which will take the static snapshot in our GIS to its form at some future time? We have many ideas about how the system works and our GIS operations — even display and map generation — can only be performed by applying those ideas. Our GIS operations are typically used only to take us in a single step to that future time. That step may be an hour or a decade. The step is most often implicit and unacknowledged. For example, a standard GIS overlay procedure results in a map which is intended to show (or suggest) the relative impact of some decision on the landscape or cityscape. Where will money for development likely be spent? Where will neighborhoods of $100,000 homes be built? Where should a new hospital or school be located? Where should a trail be placed to minimize the impact on a threatened habitat or species yet be sufficiently interesting to park visitors? How will the maximum flow in a local stream be affected by new development?

As regional and community planners, engineers and scientists, politicians, and citizens, we all have ideas about how the components of a landscape operate. We also have ideas about how the landscape is laid out. Now that we have successfully formalized our ideas about the mapped environment, we are beginning to formalize our ideas about its dynamics. As we store digital maps, we are now beginning to store digital models which, when combined with the maps, allow us to watch alternative futures unfold as movies before our eyes.

Thus far, most of the landscape simulation modeling has been developed by scientists narrowly focusing on the subject matter of their chosen disciplines. To be valuable for land managers, these academically focused endeavors must be integrated to allow for a

single interdisciplinary, dynamic simulation environment. Such models are emerging from the workbenches of the research and development community. In this article, we will review several such models and then look at what the future holds in combining such models into management-oriented simulation capabilities within future geographical modeling systems (GMS).

General Approaches to Dynamic Landscape Simulation Modeling

GIS specialists in the future will be seeing increased access to the ability to simulate the landscapes under their control. Two basic types of utilities are becoming available: simulation models and simulation modeling environments. Simulation models contain the simulation rules necessary to predict the future state of a system. The user is required to provide only the initial state of the system under consideration. These models are most common where the science is both well understood and relatively tractable. Spatially explicit simulation models include:

- The Groundwater Modeling System (GMS), Surface Water Modeling System (SMS), and Watershed Modeling System (WMS). This suite collectively captures a large number of spatially explicit models that are established and validated. The models run independently, but within a common data and graphical user interface framework. The internet address is *http://www.ecgl.byu.edu/software*
- The Modular Modeling System (MMS). This system is composed of a large number of simulation modules arranged in libraries. They include groundwater, surface water, weather, climate, stream, reservoir, insolation, and vegetation submodels. Users graphically assemble and parameterize these submodels into a single model representing the landscape being modeled. The internet address is: *http://www.usbr.gov/rsmg/warsmp/mms/*

These models predefine all of the interactions among landscape components and are generally based in physics and/or engineering. They rely, where possible, on first principles.

There are more troublesome components of the landscape that do not easily yield "hard science" and cannot be predefined in canned simulation modes. The interactions between plants and animals and their environments are sufficiently unique in local setting to require the modeler to be directly responsible for the design and development of the model. For this type of exercise, simulation modeling environments are necessary. The following represent this class:

- SWARM is a set of programming objects that forms an excellent foundation for developing simulation models. Standard visualization, time/calendar management, and object interaction objects provide an excellent start for software programmers developing simulation models. The internet address is *http://www.santafe.edu/projects/swarm*
- The Spatial Modeling Environment (SME) is demonstrated in an example below. It allows a scientist/manager familiar with the processes in a landscape to develop a model that is then run simultaneously in every gridcell represented in a raster GIS database. The required familiarity with a programming language is virtually limited to the operation of very user-friendly dynamic simulation environments that employ simple graphical user interfaces. The internet address is *http://kabir.umd.edu/SMP/MVD/*

Introduction to Dynamic Model Development

To understand the process of digitally capturing our ideas about how a landscape works, we must first become comfortable with the idea of capturing ideas about the dynamics of systems into software. A number of excellent commercial software products are on the market that provide very easy environments for allowing us to develop our ideas of how things work. Traditionally, ideas about system dynamics have been captured using "analytic" approaches. Complex differential equations are developed to describe the relationships between different components in a system. Once developed, the system of equations can be studied, solved for different variables, opti-

mized, and scrutinized. Skilled mathematicians are required to construct, analyze and interpret such systems of equations. Although they are exceptionally powerful, analytic models have a few serious drawbacks. First, many scientists specializing in ecology, planning, and engineering find the mathematics too daunting. More importantly, however, they cannot easily accommodate random occurrences, thresholds (resulting in noncontinuous equations), expert systems, and systems of logical statements. The answer to both of these shortcomings is "numerical" modeling. The numerical modeler defines a system in terms of difference equations instead of differential equations. Difference equations are much simpler algebraic equations that describe how some system component at any time step is a function of the state of the system at the previous time step. This information is then used to run simulations of the system under investigation.

Let's do a simple example that we will capture in the Stella programming environment. We have the following information on a population of rabbits:

starting population (Population): 100 rabbits

carrying capacity (CC): 10,000 rabbits

maximum reproductive rate (MRR): .1 rabbits per month

adjusted reproductive rate (ARR): MRR * (CC – Population)/CC

A simple Stella model can be created with this information (see Figure 1). The rectangle identifies "Population" as a state variable. Such variables capture the current state of the system during a simulation. The pipeline feeding into the rectangle adds units to the rectangle at a rate controlled by the "valve," which here is called "Births." The other circles hold variables or equations. Arrows are used to graphically identify the variables used to calculate the values in the circles at the arrow end of the lines. Consider the arrows feeding into "Births." We read this diagram by stating that "Births" is a function of "Population" and "ARR." Similarly "ARR" is a function of "CC" and "MRR." All that is missing from this view are the functions. These are accessed in Stella by double-clicking on the circles. After completing this process for each equation, Stella can be asked to show us all the equations in a text format (see Table 1). Note that the actual order of execution will proceed from the bottom to the top.

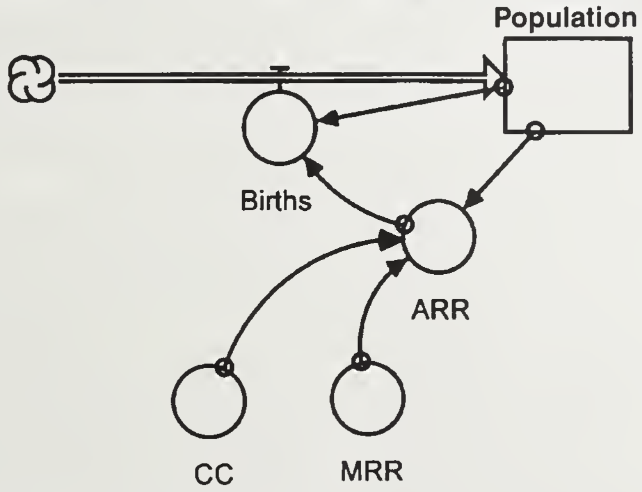


Figure 1
Simple population model

Once our simple model has been completed, we are interested in looking into the future of our rabbits. Running the system produces the graph in Figure 2. Using only simple algebra we have created a logistic-curve growth model with a fixed carrying capacity of 10,000 rabbits. This approach makes dynamic simulation modeling accessible to virtually any land management professional.

You can imagine modifying this simple rabbit model to capture the behavior of foxes hunting the rabbits. Your ideas of the ability of

Table 1
Equations

Population(t) = Population(t – dt) + Births • dt

INIT Population = 10

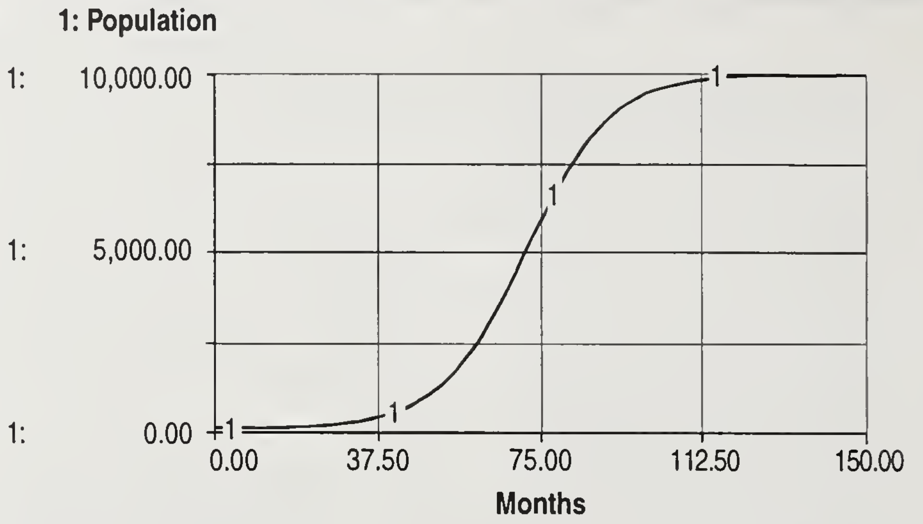
INFLOWS:
Births = ARR • Population

ARR = MRR • (CC – Population)/CC

CC = 100

MRR = .1

Figure 2
Simulation output



foxes to capture the rabbits, the food value derived from consuming the rabbits, and the foxes' reproductive rates can be captured in simple algebra, too. You then create a model and plot the populations of rabbits and foxes over time as they interact with one another. You might then want to add in a grass model to represent rabbit food and drive that model with simulated weather. If you have ideas about how such a system operates, you can capture those ideas in software that will reflect the implications of your ideas.

We are now going to take a rather large step to the next example. To further explore the use of dynamic simulation modeling for environmental, economic, and/or engineering systems, consider a series of textbooks by Hannon and Ruth (1994; 1997). The authors have worked with an interdisciplinary team of scientists to develop complex, spatially explicit landscape simulation models based on Stella simulation modeling.

Consider your traditional raster-based GIS. Associated with each gridcell are sets of values captured in a series of maps representing values for topology, fox and rabbit populations, and grass cover. Assume now that each cell is homogeneous for these traits and that they can be used to initialize a Stella-type model. This model uses the Stella language demonstrated in Figure 1 with one extension. Any equation (represented by the circles) can also be a function of variables associated with neighboring cells. With this extension, rabbits and foxes can be free to move between neighboring cells. Rabbits might move around randomly with higher motivation under predation pressure. Foxes might be motivated to move when their prey densities are low. Such an extension, along with the ability to run Stella models simultaneously for every gridcell associated with a GIS raster map, is supported with the Spatial Modeling Environment (SME) developed by Maxwell (1993; 1995).

A Sample Dynamic Landscape Simulation Model

The author and colleagues used Stella and SME to develop a series of landscape simulation models. One such model is the Fort Hood Avian Simulation Model (FHASM), a simulation model developed to compare the long-term implications of alternative management patterns in time and space with respect to populations of two threatened bird species. The internet address is *http://blizzard.gis.uiuc.edu/htmldocs/HoodModel/*

Background

The black-capped vireo *(Vireo articapillus)* is a small, greenish songbird that breeds in Oklahoma and Texas and overwinters along the western coast of Mexico. This species became listed as federally endangered in 1987. Historically, the breeding range of black-capped vireos extended as far north as Kansas, but it has become restricted to the present range following the loss of appropriate breeding habitat. Black-capped vireos are habitat specialists that require hardwood scrub habitat consisting of patchy shrubs and thickets interspersed with live and dead trees. Breeding territories of black-capped vireo pairs range from 1.5 to 3 ha. Individuals return to the post from their overwintering range in mid-to-late March and leave the post for overwintering

ranges in August and September.

There appear to be two major threats to the survival of the black-capped vireo, loss of habitat and nest parasitism by cowbirds. Loss of existing breeding habitat as well as potential for future habitat occur following conversion to pasture for cattle and urbanization. Cowbirds are obligate brood parasites that lay their eggs in the nests of other species, including black-capped vireos. Black-capped vireos cannot successfully fledge both their own young and the young of cowbirds; when parasitized, they fledge only cowbirds or abandon the nest.

The golden-cheeked warbler *(Dendroica chrysoparia)* is a small, brightly-colored songbird that breeds only in Texas and over-winters in mountainous areas of Central America. This species became listed as federally endangered in 1990. Golden-cheeked warblers are habitat specialists that require mixed hardwood stands consisting of ash, juniper, and a variety of oak species. Breeding territories of golden-cheeked warbler pairs range from 2 to 20+ ha. Individuals return to the post from their overwintering range in March and leave the post for their overwintering range in June and July.

The major threat to the survival of the golden-cheeked warbler appears to be loss of habitat following urbanization or conversion to pasture. While the impact of cowbirds on the reproduction of golden-cheeked warblers is relatively unknown, it is expected to become a greater problem as habitats become more fragmented.

Approach

The approach used for this exercise followed the general steps listed below:

1. Identify the management questions.
2. Identify the available resources with respect to funding, personnel, expertise, software, hardware, and time.
3. Develop a single-cell model using the Stella simulation environment.
4. Develop raster initialization maps using GRASS (Geographic Resource Analysis Support System) geographic information system translation, compilation, and multicellular simulation using SME (Spatial Modeling Environment) program.
5. Conduct sensitivity analysis.

The Model

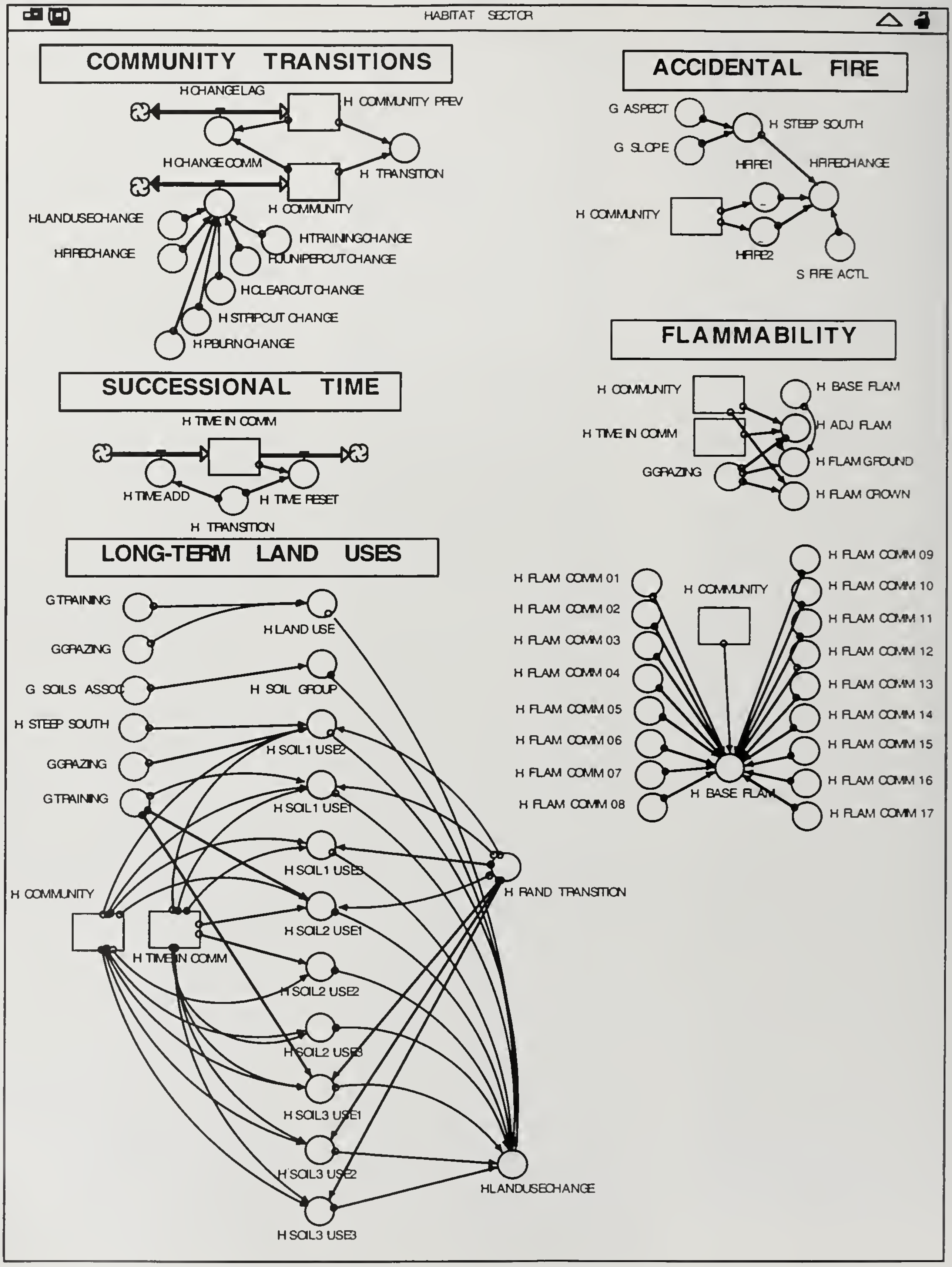
The Stella model was divided into the following submodels: avian ecology; plant community; management; and impacts. Figure 3 represents the plant community submodel. Compare this model with the simple Stella model in Figure 1. Equations representing the transition of the model between time steps were extracted from the literature, from experts at the study area, and from other expert opinion. This submodel was carefully broken into smaller components. Similar submodels were developed for the avian ecology, management, and impacts. The submodels depend upon one another with connections not obvious in the figure. This makes it possible to reduce the spaghetti of lines that would otherwise occur between components of submodels.

Each submodel was developed independently of the others for the purpose of rapid testing and debugging. Completed submodels were then patched together to form the final cell model. This model was then tested and debugged as much as possible within the Stella modeling environment. Once the developers were satisfied, the model was then set up to run simultaneously in every gridcell across a GIS database using the Spatial Modeling Environment (SME). SME converted the Stella equations into executable C++ code, which ran separate models for each gridcell. The GIS data were used to initialize the model; the model then generates system state maps for each ensuing time step. For this model the time step was three months and the gridcell resolution was 200 meters.

A few additional tricks were employed. The state of a particular gridcell is a function not only of the state of that gridcell in the previous time step, but also the state of the neighboring gridcells in that time step. The SME process provides an approach to allow for this addition to Stella programming. SME also allows the modelers to write out GRASS GIS maps, run UNIX commands (GRASS commands), and read GIS maps back into the running model. For this model, GRASS was used to assist with fire patch simulation and with the distribution of spring bird immigration — functions not easily performed in the Stella/SME environment.

The final Stella/SME/GRASS model was then ready to simulate

Figure 3
Plant community submodel



the response of the landscape to alternative land management patterns. Figure 4 shows a sample output of the simulation model. The left image represents the GIS-supplied vegetation community used to initialize the model. The right image shows increased fragmentation of the landscape under a particular land management scenario. Numerous land management scenarios are possible; results are best viewed as movies. To make the model as easy as possible to use, we developed an HTML-based interface for the Web. Managers input a number of management decisions into the interface including management policies, vegetation and bird response parameters, and desired outputs. The request is queued on a machine located in the developers' offices at the Geographical Modeling Systems Lab. The internet address of the lab is *http://www.gis.uiuc.edu.* Once the simulation run is complete, the results are displayed in HTML pages. Details of the FHASM model, sample runs with outputs, and the manager's model execution forms can be viewed at *http://blizzard.gis.uiuc.edu/htmldocs/HoodModel*

Conclusions

For those of you who have determined that your desktop GIS is insufficient for peering into the future and seeing the consequences of proposed land management options, powerful new capabilities are emerging from the R&D community. Your GIS allows you to capture our understandings of the state of the landscape through improved remote sensing and digitization techniques. These form the basis for raster, vector, and point maps associated with information stored in database management systems. We then have incredibly powerful tools for analyzing, overlaying, validating, measuring, and interpreting those maps. We are still retaining understandings of how the landscape changes over time in our minds. Scientific models emerging from laboratories based on first principles now provide powerful models for predicting flows of water, erosion/deposition rates, and weather patterns. These are now being packaged into powerful land management software environments. For the less tractable processes, which include vegetation growth, population dynamics, movements of individuals, and interactions between the biotic

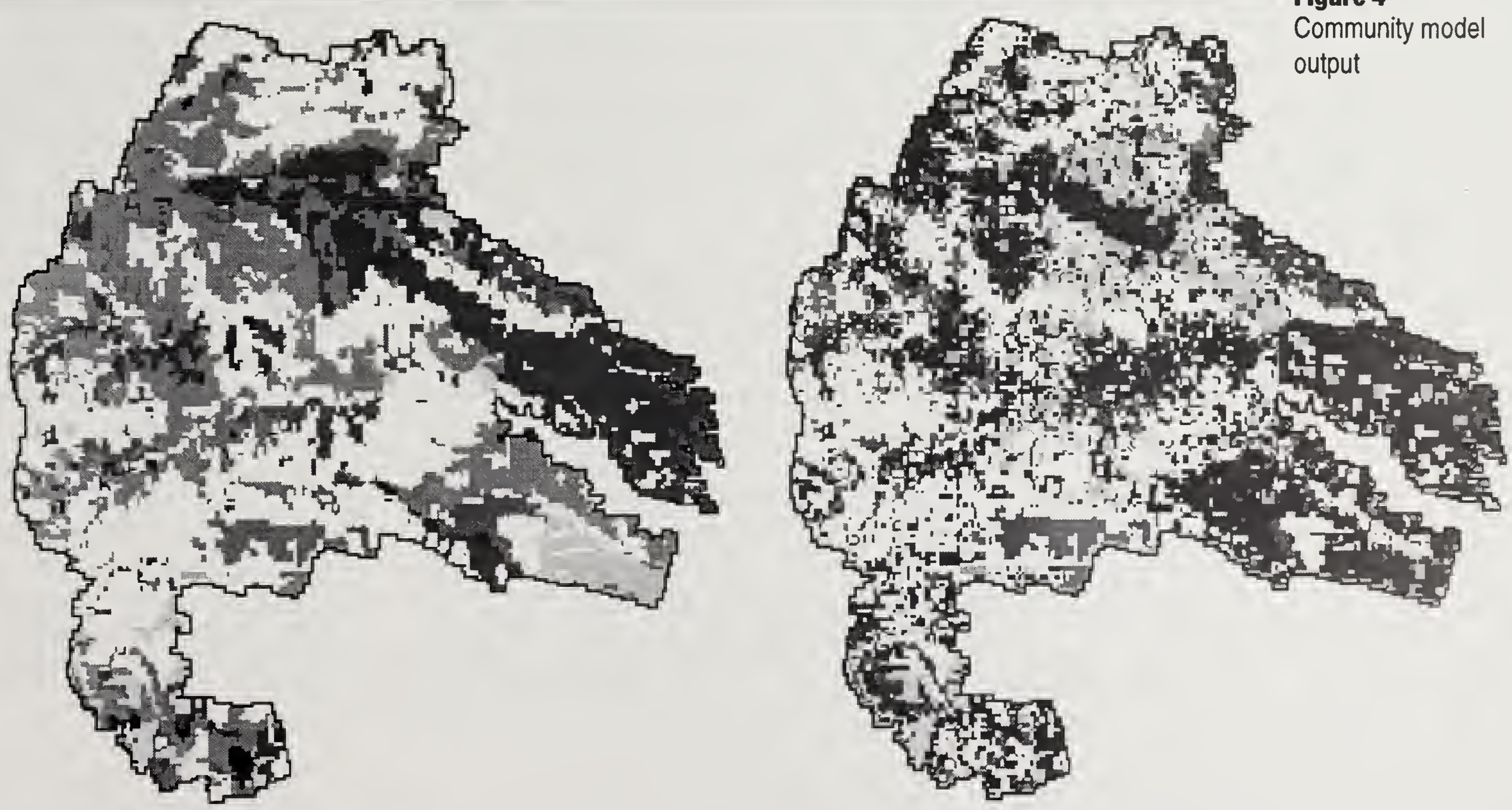


Figure 4
Community model output

and abiotic components, powerful new spatially explicit simulation modeling environments are being developed. Using such environments any number of locally specific models are being developed to address questions of management impacts on populations, habitat suitability, economics, and human settlement patterns. If you want supercharged GIS, hold on to your systems. It's coming soon. If you want it faster, visit your favorite university's GIS lab.

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SoilView: A Soil Survey Report for Today's Technology

Tom D'Avello
Natural Resources Conservation Service
Champaign, Illinois

Robert L. McLeese
Natural Resources Conservation Service
Champaign, Illinois

Background

The traditional soil survey reports developed through the National Cooperative Soil Survey Program are the product of the most comprehensive natural resource inventory in the world. The format of the report has been unchanged for the past 40 to 50 years, consisting of a bound document with three major sections: text, tables, and maps.

This medium and format can be cumbersome to use, requiring the user to shift back and forth between maps of interest and corresponding nonspatial data. In addition, many of the terms and concepts used in the report are unfamiliar to many users (Valentine, et al., 1981). The goal of a soil survey report is to provide consistent, reliable information on the pattern of occurrence and behavior of soils for multiple land uses and management. Any limitations regarding ease of use and understanding hamper this goal.

Current Status

There is a soil survey for most of the 3,000 plus counties in the United States. However, the scale, base map, and classification system used vary from county to county. The current emphasis is to bring consistency to the soil survey across political boundaries using the knowledge gained from the past 100 years (Indorante et al., 1996).

All soil surveys will now be produced using USGS digital orthophotography at a scale of 1:12,000 or 1:24,000 as a base map. All text, tables, and spatial data will be in digital form and archived as ASCII text, delimited ASCII text, and DLG-3 Optional file formats, respectively. Availability of the digital data will be through the Natural Resources Conservation Service's (NRCS) National Cartographic Center of Ft. Worth, Texas, or respective state offices.

Is This Enough?

Even with the digital emphasis, we were still concerned that we would not be meeting the needs of most of our users. Formal and informal meetings and user surveys confirmed our suspicion. Most users don't have $1,000 to $20,000 tied up in GIS software. Those who do don't always have a day or two to import and manipulate data. Users would prefer to have a digital product that comes ready to use.

What Users Want

Many people are familiar with and use CD-ROMs, multimedia educational software, World Wide Web browsers, etc. Once these products came onto the market, the thought of creating an interactive, multimedia soil survey took hold. Our journey towards creation of an interactive digital soil survey began in 1995 with funding from the National Soil Survey Center of the Natural Resource Conservation Service and the development of a wish list of features that included the following:

- the ability to run under Windows
- pure database capability
- having links between maps, tables, and text
- map manipulation via database manipulation
- hyperlinks for graphics and text
- the ability to view multiple map "sheets" as one image
- photographic background capabilities
- ease of use

A review of available software led us to ArcView 2.1 and ArcView Publisher as the products that met all of the user requirements.

SoilView

Data Preparation

The desire was to include all of the data for a soil survey on one CD. In order to accomplish this, some data manipulation was required, primarily with the digital orthophoto quarter-quads (DOQQs), which average 50 megabytes each. The DOQQs were resampled at resolutions from one to five meters using a cubic convolution method and trimmed at the 3.75' neatline, reducing their file size about 96%, while maintaining an acceptable spatial resolution. Tab-delimited ASCII tables were extracted from the NRCS map unit interpretation record (MUIR) tables, normalized, and converted to DBF files. The text data was converted into a stand-alone hypermedia document, while soil coverages were converted to shapefiles.

Figure 1
Soil survey index map

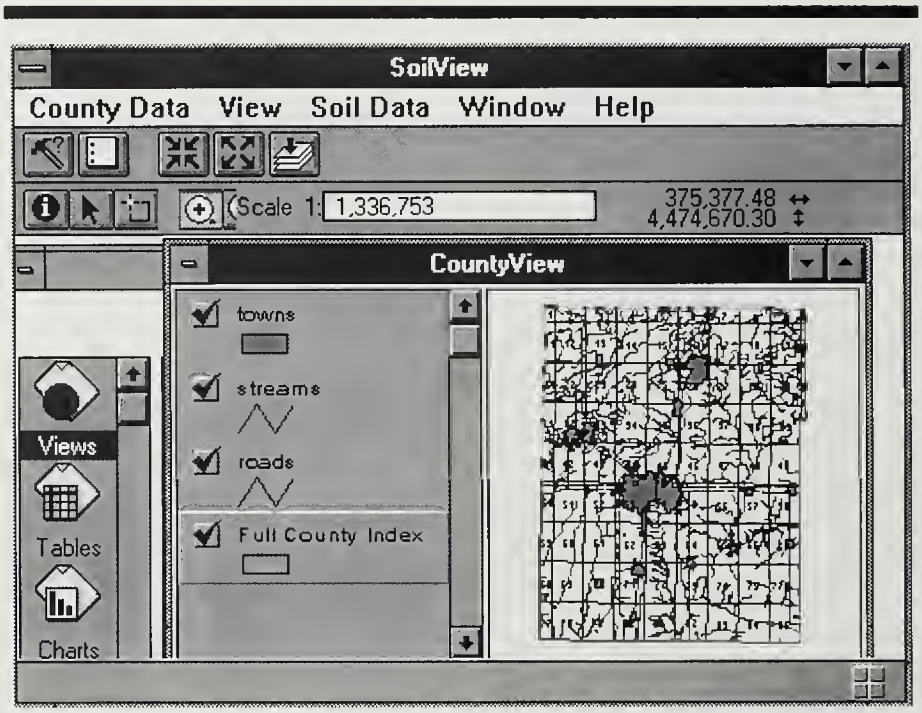
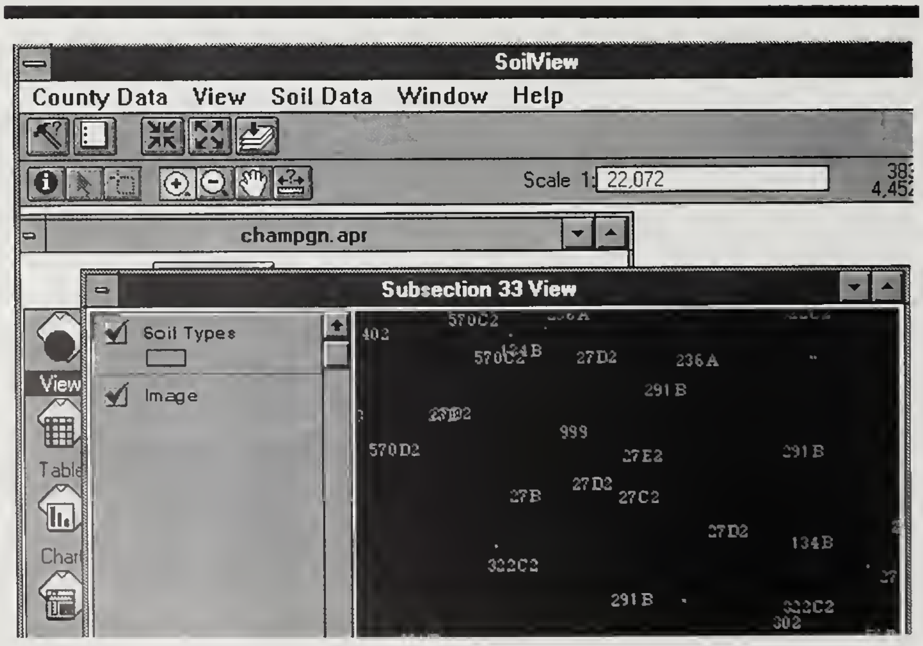


Figure 2
View of soil map



The Interface

Users of soil surveys want to determine information on the attributes of soils or determine the spatial extent of a soil's attributes, or both. In gathering this information, users most often start from a map and proceed to a table or text, and occasionally they employ the inverse of this method. SoilView allows the user to pursue either route.

SoilView uses a customized ArcView project with fewer buttons and tools, unique menus, and several customized tools, with the goal of making the software as easy to use as possible without limiting the essential functionality required to utilize the survey. Our findings indicated that most users are not experienced GIS users and most likely will not become so.

As part of the project start-up, all tables, text, and a predefined view of the soil index map become available. Once a user opens the "County View" view, he/she may select a particular soil map by using a tool called "Select by Point," or "Select by Rectangle" (Figure 1). Scale-dependent display of the shapefiles for the quarter-quad views is set at a scale of 1:30,000 to reduce drawing time and clutter. Figure 2 is an example of a view

showing the interface to provide an idea of the menus, buttons, and tools that are available. Figure 3 is a close-up with the digital orthophoto as a backdrop to provide an idea of the spatial resolution of the image. Our reviewers would rather have imagery at a higher resolution, but not at the expense of system performance or limitations on file size.

Tabular data are available just as a user would find them in a soil survey report (see Figure 4 for an example). However, there are a few exceptions. For example, tables in the hard copy soil survey list data ranges as one data field for certain properties like pH, permeability, and water table depth. SoilView maintains the original MUIR table structure, which has a data field for both the minimum and maximum values of a given soil property.

The text of the soil survey is available from the menu as a stand-alone hypermedia file. It functions like a Windows Help file with pop-up windows and hyperlinks to other text or graphics. Figures 5 and 6 give an example of the text capabilities.

Where the Project Is Now

The beta release was completed during the summer of 1996 and distributed to approximately 150 individuals throughout the world. All of the responses received from the review of the beta release were favorable in terms of ease of use and, notably, the concept of providing the user with a bundled package of software and data. We estimate that this product could re-

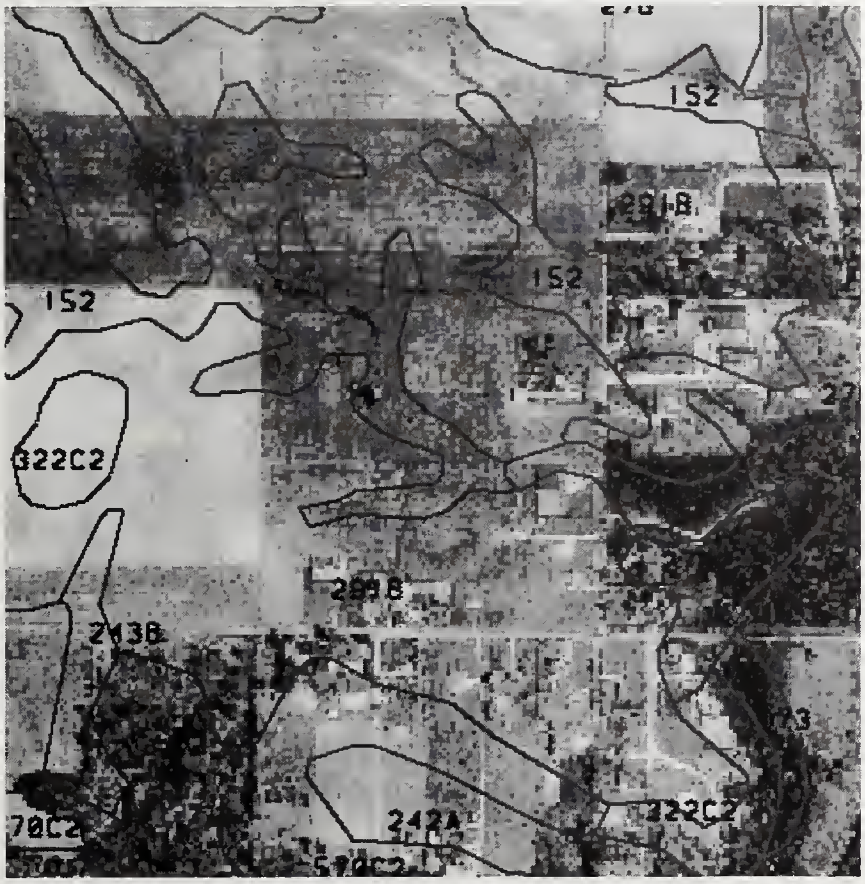


Figure 3
Enlarged view with digital orthophoto backdrop

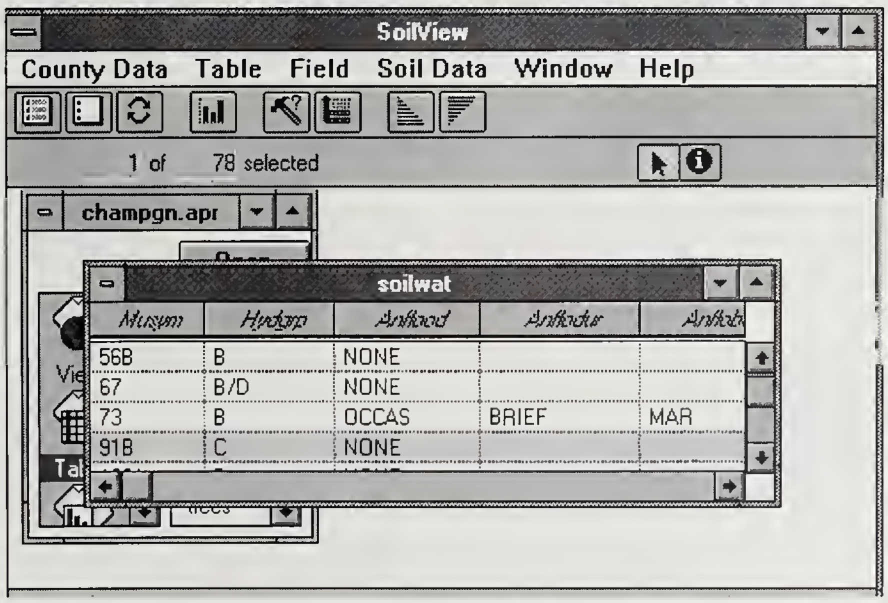


Figure 4
Portion of soil and water table

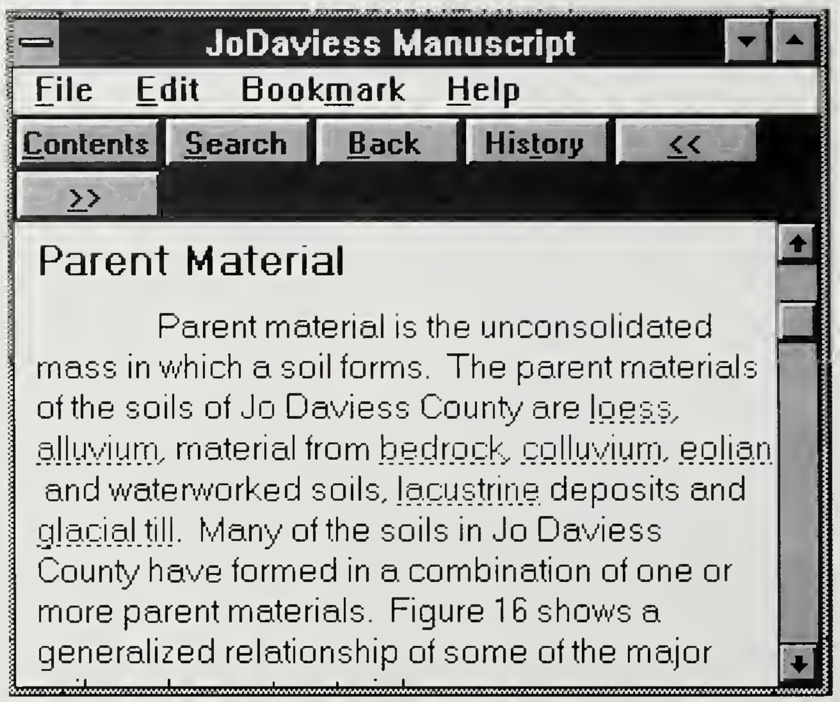


Figure 5
Sample of soil survey manuscript window

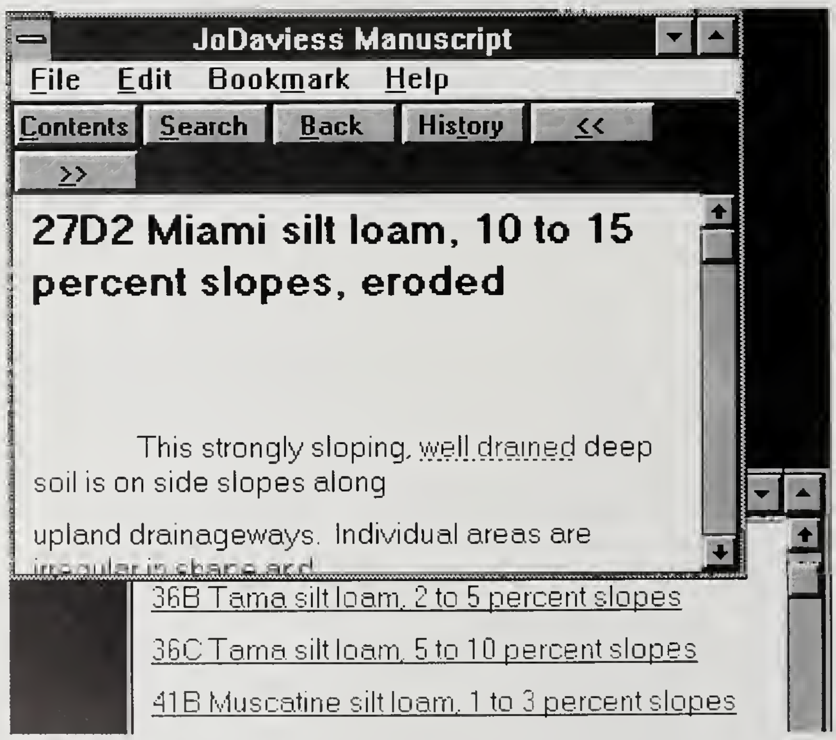


Figure 6
Soil map unit description and hypertext legend

duce the time from completion of field work to publication to between one-fourth and one-sixth. Based on the evaluations and recommendations we received from the beta test, our final version will include the following:

- Digital Raster Graphics (DRGs) as a theme
- Annotation as a theme
- Hot links to images and graphics from soil map view
- Improved Help screens specific to SoilView

What's Ahead?

Based on the positive feedback we have received, all soil survey updates will be published on CD-ROM with the SoilView interface. There will still be traditional hardcopy reports produced, but we are emphasizing the CDs, due to their low cost, ease of use, and quicker publication schedule. We plan to have the final release ready by late 1997. The first Illinois counties that will be published using this format will be McHenry, St. Clair, and Jo Daviess.

References

Indorante, S. J., R. L. McLeese, R. D. Hammer, B. W. Thompson, and D. L. Alexander (1996). "Positioning Soil Survey for the 21st Century." *Journal of Soil and Water Conservation* 51: 21-28.

Valentine, K. W. G., W. C. Naughton, and M. Nava (1981). "A Questionnaire to Users of Soil Maps in British Columbia: Results and Implications for Design and Content." *Canadian Journal of Soil Science* 61: 123-135.

GIS Applications for Coordinating Watershed Priorities between Agencies in Illinois

Joel Cross
Illinois Environmental Protection Agency
Springfield, Illinois

Background

In 1994 Governor Jim Edgar's administration created the Natural Resource Coordinating Council (NRCC) to address and coordinate issues between the state's natural resource and environmental agencies. The NRCC is comprised of the directors of eight Illinois state agencies (or their designated representatives), including the Environmental Protection Agency; the Pollution Control Board; and the Departments of Natural Resources, Agriculture, Public Health, Commerce and Community Affairs, Transportation, and Nuclear Safety.

Several committees were subsequently created by the NRCC to address specific natural resource issues, including the Watershed Management Committee (WMC). The NRCC has charged the committee with the following mission:

> *To serve in an on-going capacity to coordinate watershed-based activities and programs among the state's natural resource and environmental agencies. The Committee will also serve a liaison function to provide for the coordination of federal and local involvement in watershed activities. An overall strategy will be developed that will include specific recommendations by the Committee for review and endorsement by the Natural Resource Coordinating Council (NRCC).*

The Watershed Management Committee has identified several coordination issues to be addressed in order to fulfill its charge. These include coordinating the following between agencies: data collection and watershed assessment information, watershed planning activities, the development of watershed indicators, and watershed priorities.

Identification of Watershed Priorities

Within Illinois, the Illinois Environmental Protection Agency, the Departments of Natural Resources and Agriculture, and the Natural Resources Conservation Service of the U.S. Department of Agriculture have internal mechanisms in place to select and prioritize on a geographical basis areas where limited funds and resources are to be directed. Using a GIS, the priority areas of the various agencies were compared on a watershed scale to determine where the watershed-based efforts overlap. Once identified, coordination of activities and resources are focused on these watersheds to enhance each agency's individual activities and prevent potential duplication of effort.

Agency-Specific Process for Identifying High Priority Areas

Illinois Environmental Protection Agency

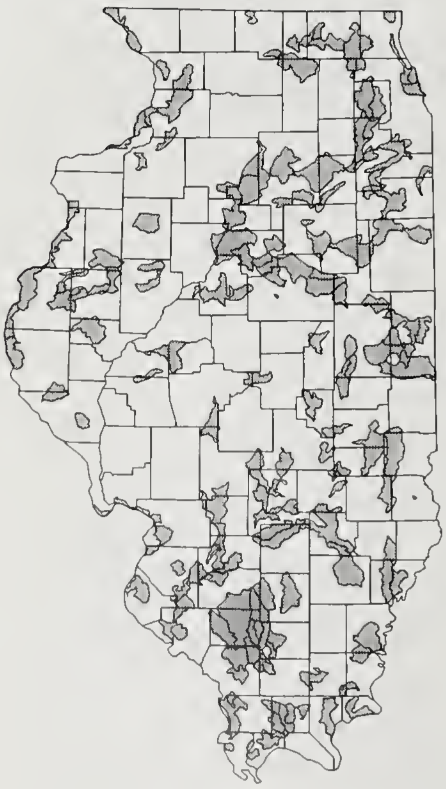
In 1993 the Bureau of Water of the Illinois Environmental Protection Agency began the process of restructuring its program activities in all areas around a priority watershed management approach. This restructuring includes both water pollution control and drinking water programs and focuses on restorative as well as preventive measures directed to both surface and groundwater resources.

The report, *Targeted Watershed Approach: A Data-Driven Prioritization, March 1997,* describes the framework for prioritizing program activities and presents the resulting watershed priorities. To the extent that flexibility is available in mandated and delegated responsibilities under the federal Clean Water

Act, Safe Drinking Water Act, and state statutes, the Bureau of Water targets those program and watersheds that have the greatest impact on human health issues and ecosystem protection. Therefore, watersheds are targeted for specific action, and the balance of available programmatic resources are used to maintain a statewide baseline program.

The approach described in the report significantly broadens the scope, purpose, and geographic targeting of the bureau's program activities from what they were prior to 1993. In addition to focusing on water quality problems and restorative measures, the approach also incorporates criteria for identifying high-quality resources and protection measures to provide a more comprehensive approach to geographic targeting and prioritization of water resources, rivers, streams, Lake Michigan, inland lakes, and groundwater.

Figure 1
IEPA priority watersheds



The overall goal of the approach described in the report is to focus programs and resources on those areas having the greatest need for correction, protection, or restoration while continuing statewide program activities. Specific objectives for applying the approach in Illinois are listed below:

1. Identify watersheds with the most critical water quality problems and direct programs and resources to the solutions of those problems.
2. Direct programs and resources to those watersheds considered to have the highest potential for improvement.
3. Protect existing high-quality resources through a preventive approach to water quality management.
4. Identify watersheds where there is a need to coordinate multiple program priorities.

High-priority watersheds identified through the targeted approach described in the 1997 report are depicted in Figure 1. Priority watersheds are re-evaluated on an annual basis, in order to incorporate any new monitoring information collected from the previous year to keep the watershed prioritization process current.

Illinois Department of Agriculture

Since their inception in FY 1986, Illinois's soil conservation cost-share programs have collectively enabled the construction of several thousand soil erosion control projects in every county of the state. The result is savings of millions of tons of soil annually on hundreds of thousands of acres of land. This investment of financial resources by the state is making a significant contribution to cleaner water and to the goal of "T," or tolerance loss levels, on all agricultural lands by the year 2000.

Two soil conservation cost-share programs were introduced in FY 1986 and operated through FY 1992, the Conservation Practices Program (CPP) and the Watershed Land Treatment Program (WLTP). Both programs were funded with appropriations made by the Illinois General Assembly to the budget of the Bureau of Land and Water Resources of the Illinois Department of Agriculture. Public funds were used in combination with private dollars for conservation projects approved by Soil and Water Conservation Districts. The CPP and the WLTP were successful examples of combining state resources with private-sector dollars to effectively reduce soil erosion and improve water quality.

Funding for the CPP was restored in FY 1996 through the Conservation 2000 program. The Conservation 2000 – Conservation Practices Program (C-2000 – CPP) combined the best, most efficient aspects of the previous CPP with several new approaches. The result is an effective and cost-efficient program targeting the most erosion-prone areas of the state to reduce soil erosion and improve water quality.

C-2000-CPP provides cost-share assistance and other financial incentives for the construction or adoption of conservation practices that conserve soil and protect water quality. The objectives and highlights of the C-2000-CPP are listed below:

1. Assist landowners with highly erodible cropland exceeding one and one-half times the tolerable soil loss levels (1.5T) in constructing practices to conserve soil, protect water quality, and reduce flooding.
2. Target cost-share monies to deliver effective and cost-efficient assistance to meet "T" by 2000 and provide the greatest public benefit possible in conserving soil productivity and protecting rivers, streams, and lakes. Figure 2 shows high-priority counties (those with a significant percentage of cropland acres exceeding 1.5T).

Illinois Department of Natural Resources

The identification and characterization of areas rich in biological resources (resource rich areas, RRA) used an analysis of natural resource data based on GIS technology guided by scientists with extensive knowledge of ecosystem concepts and Illinois biota.

A landscape-level approach envisions the existence of a system of areas that would protect, maintain, and enhance the living natural resources of Illinois. The specific ecological roles of sites were determined to be the following:

1. Provide areas large enough to allow for the natural dynamic of ecosystems and to allow management to simulate natural forces to meet the needs of various communities and species.
2. Protect, restore, and enhance areas to provide the ecological requirements for animals and plants that need large areas.
3. Include representative examples of the natural communities of Illinois.
4. Protect areas with significant habitat and species diversity.
5. Protect habitat types that are diminishing at an alarming rate, such as wetlands, forests, prairies, and biologically significant streams.

Watersheds, as identified by the Illinois EPA, were used as the geographic unit for evaluation and analysis. Criteria for the evaluation and characterization of RRAs were selected because (1) they emphasized ecologically important characteristics; (2) they were available as statewide digital databases; and (3) they were suitable for analysis using Illinois EPA watersheds. The criteria, analysis, maps, and summaries in this report are based on ecological characteristics, economics, recreational interests, and other considerations that were not explicitly accounted for in this effort. Watersheds were evaluated using the following variables:

1. Forest — percentage of the watershed.
2. Wetlands — percentage of the watershed.
3. Illinois Natural Areas Inventory — total area.
4. Biologically significant streams — total length.

The four variables were given equal weight in the analysis. Each watershed was ranked against all other watersheds for each variable. Watersheds were placed into 10% deciles for each variable and given a score of 10 points if they were in the top decile, 9 points in the 81-90% decile, 8 points in the 71-80% decile, etc. Watersheds in which a variable did not occur were given a score of zero for that variable. The scores for each variable in each watershed were summed; the maximum possible cumulative score was 40. Watersheds were defined as resource rich if their cumulative score ranked in the top 10%. This quantification resulted in the inclusion of watersheds having a score of 26 or greater (actually the top 12% of all watersheds due to tied scores). The RRAs are shown in Figure 3.

Efforts to involve the state's sub-

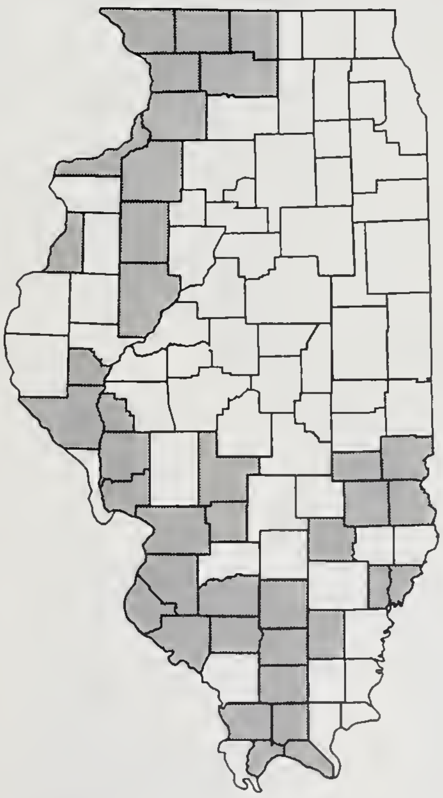
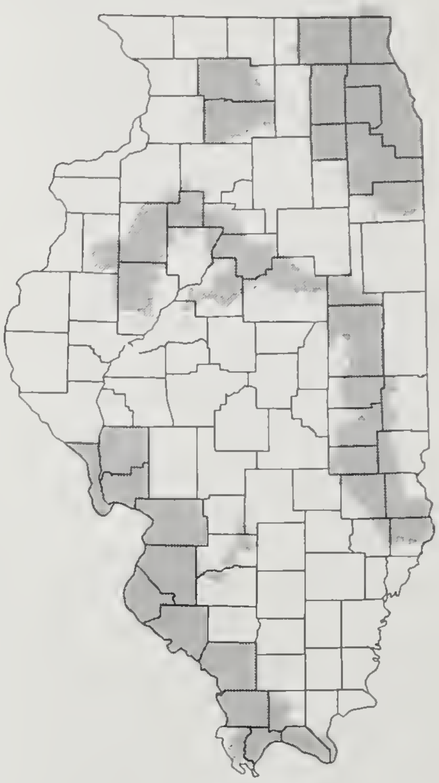


Figure 2
IDOA priority counties

stantial base of private landowners began with the establishment of the Ecosystems Program and recruitment of Ecosystem Partnerships. This voluntary, incentive-based program requires the commitment of local public and private partners before application to the program. Many of the currently designated Ecosystem Partnerships are located in the RRAs previously identified (Figure 4). Through partnerships, the Ecosystem Program provides financial and technical assistance to private landowners interested in maintaining and enhancing both ecological and economic conditions in key watersheds throughout the state. The program includes habitat restoration, enhancement, and protection components, as well as funding for education and research projects that will benefit students, managers, and concerned citizens statewide.

Figure 3 IDNR resource rich areas

Figure 4 IDNR ecopartners



USDA, Natural Resource Conservation Service

Conservation Priority Areas within the state are established through the USDA-NRCS EQIP Program (Figure 5). Conservation Priority Areas are selected through an application process. Local planning committees may submit applications. Applications are reviewed and ranked using the USDA-NCRS rating worksheet. Rating criteria include: environmental benefits, producer participation, program evaluation, project support, and contributions of others.

Upon completion of the rating process, the top projects are selected and must receive the approval of the NRCS State Technical Committee, and the State Committee of USDA's Consolidated Farm Services Agency (FSA). Once this has been completed, the approved applications are submitted to Washington. USDA- NRCS has final approval over the Conservation Priority Areas to be selected and the level of funding to be provided.

Using GIS to Compare Priority Areas among Agencies

Each agency provided a GIS coverage or list of their priority areas to the Watershed Management Committee. For those agencies unable to provide a GIS coverage,

Figure 5 NRCS priority areas

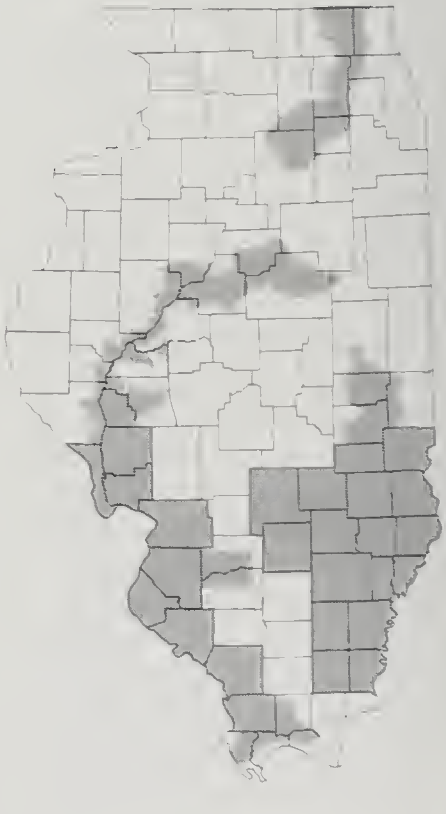


Figure 6 IEPA watershed areas

one was created from the list provided. Priority areas were identified by the various agencies by county boundaries, or watershed boundaries, or by a combination of both.

In order to compare the priority areas from each agency, the Illinois EPA's watershed delineation coverage was used to provide a consistent geographic baseline (Figure 6). A database capable of integrating the priority areas of each agency was created and included the following fields: WSID (Watershed Identifier), Illinois EPA (Priority 1 Targeted Watersheds); IDNR (Ecosystem Partnerships or Resource Rich Areas); IDOA (Priority County); NRCS (Priority Areas); and Combined Score.

The Integrated Priorities map and associated database were generated using ArcView 3 software (Figure 7). The "select by theme" option in ArcView was used to intersect each agency's coverage of priority areas with the Illinois EPA watershed coverage. A value of one was assigned to all watersheds intersecting a significant portion of an agency's priority areas. The values were totaled and recorded in the Combined Score field. The Combined Score field was queried for unique values to actually produce the Integrated Priorities map.

Integrating Priorities among Agencies

The Watershed Management Committee uses the information resulting from this comparative analysis to assist in coordinating activities and resources to enhance each agency's individual activities and prevent potential duplication of effort. This information will be updated on an annual basis as each participating agency uses new data to identify its priority areas. The Watershed Management Committee has created a focus group (or subcommittee) to initiate efforts to coordinate activities within those watersheds identified as priorities for all four agencies (pilot watersheds). Specific coordination protocols and procedures for the assessment of watershed conditions, watershed planning, funding, and delivery of services will be developed for endorsement by the NRCC to streamline future coordination efforts between the participating agencies.

Acknowledgements

This article was compiled by Joel Cross. Contributing authors included Marvin Hubble (Illinois Department of Natural Resources); Terry Donohue (Illinois Department of Agriculture); Mike Branham, and Gary Eicken (Illinois EPA). Editing was provided by Joan Muraro (Illinois EPA).

Figure 7 IEPA, IDNA, IDOA, and NRCS integrated priorities

Agency Updates

Introduction

Donald Luman
Illinois State Geological Survey
Champaign, Illinois

Beginning with the 1997 issue of *Illinois GIS & Mapnotes*, a new section has been added to the publication entitled "Agency Updates." The focus of this section is to bring recent GIS and mapping developments about federal, state, local governmental, and nongovernmental organizations to the attention of *Mapnotes* readers. Because the applications of GIS and mapping have become so widespread in Illinois, it is becoming increasingly difficult to keep up to date with current initiatives around the state. The "Agency Updates" section will be a permanent feature of *Illinois GIS & Mapnotes* and will hopefully provide one means of facilitating communication among agencies and individuals involved in these rapidly evolving technologies.

The 1997 "Agency Updates" section is by no means comprehensive, but is representative of the types of agencies/organizations and applications in Illinois. It is expected that many of the agencies/organizations reviewed in the 1997 *Mapnotes* issue will be "updated" next year, and hopefully a number of other additional agencies will be included. If your agency or organization would like to be contacted for the 1998 *Mapnotes* issue, please send your name, affiliation, and contact information (e.g., mailing address, e-mail, World Wide Web homepage) to:

Donald E. Luman, Editor
Illinois GIS & Mapnotes
Illinois State Geological Survey
615 East Peabody Drive
Champaign, Illinois 61820-6964

We are not requesting any additional "Updates" contributions at this time, and the *Mapnotes* staff will contact you during the second half of 1998 for your contribution.

Updates — Federal Agencies

United States Census 2000

Gail A. Krmenec
U.S. Census Bureau
Chicago, Illinois

The Census Bureau has been very busy preparing for Census 2000. We are encouraging all local and tribal governments to help us in this important national, yet truly local, task.

In preparing for the Census 2000 effort, the Census Bureau is updating its geographic database known as "TIGER," as well as preparing its Master Address File, a list of all residential units, for use in conducting the census. We have been seeking local government assistance in these efforts. We are also asking local, regional, and state governments to start forming Complete Count Committees for their areas. These committees are charged with the task of promoting the census and motivating people to participate. Later this year we will hold a series of informational meetings throughout the state to explain Census 2000 more fully and to explain how you can work with us to ensure the best census yet. To enhance the understanding of the many geographic programs that involve local participation, each is summarized below.

Census TIGER Programs

The TIGER Improvement Program

This program provides all local government, regional, and metropolitan agencies the opportunity to assist the Census Bureau in locating and updating street features, street names, and address ranges identified as missing or incorrect in the TIGER database. This information is needed to link U.S. Postal Service addresses with the TIGER data base.

Census Map Preview

The Census Bureau wants every jurisdiction to have an early picture of the content in the TIGER data base. For those local jurisdictions that will not receive maps produced from TIGER through other programs, the Census Bureau will provide Census Map Preview map sheets. Local participants may use these maps to furnish the Census Bureau with updated street features and their names.

Local Update of Census Addresses (LUCA)

The LUCA program offers all local governments the opportunity to review and update the census list of individual addresses for their communities. Public Law 103-430 calls for this review to be

conducted by locally designated census liaisons who must agree to maintain the confidentiality of the information on the census address list. The regional offices of the Census Bureau will maintain contact with the liaisons and provide feedback on the handling of submitted corrections in accordance with Public Law 103-430.

On a more informal and as-needed basis, Census Bureau regional office staff also may request address reference materials or information from regional planning agencies, counties, functioning minor civil divisions, places, American Indian reservations, and Alaska Native villages to support ongoing geographic operations.

Geographic Areas Programs

In these programs, localities use census maps or files to report boundary information for legal/administrative areas and to delineate statistical areas. These areas provide the framework for the tabulation of census data.

The Boundary and Annexation Survey

The Census Bureau normally conducts a Boundary and Annexation Survey (BAS) each year to maintain the inventory of general purpose governments and to obtain up-to-date information about the boundaries of larger population entities. All legal entities, regardless of size, will be included in the BAS from 1998-2000.

The Statistical Areas Programs

This program enables local participants to delineate, following Census Bureau guidelines, statistical areas such as census tracts, block groups, census-designated places, and census county divisions.

Additional Geographic Programs

These include the update of school district and congressional district boundaries by participating state officials; the update of traffic analysis zones and assistance in the place of work program by metropolitan planning organizations; and other American Indian and Alaska Native Areas Programs designed for federally recognized American Indian tribes and Alaska Native Regional Corporations, such as the Block Definition Project and Tribal Subdivision Program.

If you have specific questions concerning these programs, please contact the geographic staff in our regional office at 708.562.1698.

U.S. Geological Survey — Water Resources Division

Terri Arnold, Tim Brown, and Robin King
USGS Water Resources Division
Urbana, Illinois

Over the past year the U.S. Geological Survey (USGS) in Illinois has used GIS in many different projects. Below is a summary of a few applications.

The National Water Quality Assessment Program (NAWQA) of USGS has two study areas in Illinois, the Upper Illinois River Basin (UIRB) and the Lower Illinois River Basin (LIRB) (see Figure 1). The UIRB also extends into parts of Wisconsin and Indiana. The NAWQA program is designed to provide an overview of the status and trends in the quality of the nation's ground- and surface-water resources. In total, NAWQA uses 59 study units that collectively cover approximately one-third of the coterminous United States and support 60% to 70% of the population served by public water supplies.

The UIRB and LIRB study unit teams have used GIS in the last year to assess and design a strategy for water sampling in the basins. As part of this effort, coverages were created to show depth to bedrock. For the LIRB, the coverage was created from two digital sources: the updated bedrock topography map published by the Illinois State Geological Survey (ISGS/USGS) and USGS 3-arc second DEMs. The bedrock topography map, which was in ARC line coverage format, was converted to a 100-meter resolution ARC/GRID coverage using topogrid. The USGS DEMs were mosaicked and similarly converted to 100-meter resolution. The bedrock elevation grid was then subtracted from the surface elevation grid, resulting in a different grid. After inspection and the rectification of anomalies, the difference grid was contoured to create an arc line coverage depicting depth to bedrock. For the UIRB, a similar method was used, but it started with different source material. For the Illinois portion of the study unit, the Illinois State Geological Survey/USGS bedrock topography coverage (as described above) was used. For the Wisconsin portion, a bedrock elevation coverage was used created by the Wisconsin Geological and Natural History Survey. For the Indiana portion, a paper map was used depicting bedrock geology and bedrock depth. This map was published by the Indiana Geological Survey and was digitized.

The depth to bedrock coverages along with coverages of other features were used to divide the UIRB and LIRB into relatively homogeneous units. For the UIRB,

Figure 1
Location of the UIRB and LIRB study areas in Illinois

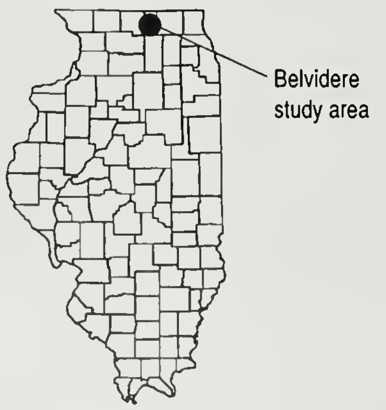
the depth to bedrock was overlaid with surficial deposits, type of bedrock, and land use in order to aggregate areas of the basin into polygons with similar characteristics. The study unit team will identify potential sampling sites based on the relatively homogeneous units so that statistical comparisons can be made.

The LIRB team used GIS to create a digital data base to assist in organizing and analyzing habitat data. Various GIS coverages were used to define Horton stream characteristics at streamflow-gauging stations. Soils, geology, ecoregion, potential natural vegetation, land use, land cover, and weighted average rainfall were also mapped for the areas around these stations.

In addition to the NAWQA studies, GIS has been used as part of a regional groundwater study of the Belvidere area in northern Illinois (see Figure 2). For this study, a database of water supply and water monitoring wells and geophysical boreholes was prepared. The database is maintained and updated as new data become available. Maps of thickness, hydraulic properties, and potentiometric surface of the hydrologic units underlying the Belvidere area have been generated using automated GIS techniques and point data from the database.

GIS techniques are being used in the regional study as a preprocessor for the groundwater flow model, MODFLOW. In this case, raster data layers (GRIDS) were generated for various input parameters used to describe the model layers. Using GRID commands, the data were aggregated to conform to the irregular spacing used in the MODFLOW model grid.

Figure 2
Location of the Belvidere study area in northern Illinois



U.S. Geological Survey — National Mapping Program

Darryl S. Williams
U.S. Geological Survey
Mid-Continent Mapping Center
Rolla, Missouri

The U.S. Geological Survey (USGS) is the nation's largest natural resources, science, and civilian mapping agency. The USGS works with hundreds of organizations throughout the United States and the world to provide reliable, impartial information needed by resource managers and planners. Scientists of the USGS gather this information in every state to minimize the loss of life and property from natural disasters; to maintain water, biological, energy, and mineral resources; to enhance and protect the quality of life; and to contribute to sound and effective economic and physical development policies. The USGS is committed to providing relevant science to serve the American people.

The National Mapping Program of the USGS is managed by the National Mapping Division of the USGS. The mission of the division is to meet the nation's need for basic geospatial data, ensuring access to and advancing the application of these data and other related earth science information for users worldwide. To be successful, however, the division must leverage its resources to encourage other organizations to enter into data sharing and maintenance partnerships. New emphases are being directed toward the establishment of long-term partnerships within the National Mapping Program that strengthen the National Spatial Data Infrastructure (NSDI) and support framework concepts. Goals in support of the mission are listed below:

- Ensure the production and availability of basic cartographic and geographic spatial data of the country.
- Coordinate national geospatial data policy and standards.
- Provide leadership for the management of earth science data for information management.
- Acquire, process, archive, manage, and disseminate the land remote sensing data of the Earth.
- Improve the understanding and application of geospatial data and technology.

Copies of the Strategic Plan of the National Mapping Division, including the mission of the various divisions and related goals, are available from the following address:

Strategic Planning and Program Development
National Mapping Division
U.S. Geological Survey
MS 512
12201 Sunrise Valley Drive
Reston, Virginia 20192

The production of digital geospatial data and graphic maps comprises the largest component of the USGS National Mapping Program. Cartographic and geospatial data are compiled from aerial photographs, other remotely sensed images, historical records, legal documents, and direct field observations and surveys. The data comply with standards of content, geometric accuracy, and presentation.

The graphics accompanying this update provide a snapshot of the availability and status of selected standard USGS products in the state of Illinois. These graphics are periodically updated and

can be viewed on the World Wide Web at *http:// mcmcweb.er.usgs. gov/ status/mcmc/il/index.html*

Digital Orthophoto Quadrangles (DOQ)

DOQs are digital images of aerial photographs in which displacements caused by the camera and the terrain have been removed. A DOQ combines the image characteristics of a photograph with the geometric qualities of a map. The standard digital orthophoto produced by the USGS is a 3.75-minute, black-and-white or color-infrared, 1-meter ground resolution image.

Digital Raster Graphics (DRG)

DRGs are scanned images of USGS topographic maps. A DRG scanned image includes all map collar information. The image inside the map neatline is georeferenced to the Earth's surface. A DRG can be combined with other geospatial data files, including images to aid in the collection, review, and revision of other types of digital data, especially digital line graphs. The DRGs are available from USGS in 1-degree by 1-degree blocks on CD-ROM.

Digital Elevation Models (DEM)

DEMs are digital records of terrain elevations for ground positions (x, y, z) at regularly spaced horizontal intervals. DEMs are developed from stereo models or digital contour line files derived from USGS topographic quadrangle maps.

Digital Line Graphs (DLG)

DLGs are vector files containing line data, such as roads, streams, contours, and boundaries digitized from USGS topographic maps. DLGs offer a full range of attribute codes, are highly accurate, and are topologically structured, which makes them ideal for use in geographic information systems. DLG categories at a scale of 1:24,000 are Boundaries, Hydrography, Hypsography, Public Land Survey System (PLSS), Significant Man-made Features, Survey Control and Markers, Transportation, Vegetative Surface Cover, and Nonvegetative Surface Cover. Boundaries, Hydrography, Hypsography, PLSS, and Transportation are the only categories produced from 1:100,000-scale maps.

An abundance of information about USGS products and services is accessible through the internet at the following USGS home page address: *http://mcmcweb.er.usgs. gov/status/index.html*

For additional information about pricing and ordering, and the status of USGS geospatial data products and services in Illinois, please contact one of the following:

Rolla-Earth Science Information Center
USGS, Mid-Continent Mapping Center
Mailstop 231
1400 Independence Road
Rolla, Missouri 65401

Darryl S. Williams
USGS, Mid-Continent Mapping Center
Coordination and Requirements Section
Mailstop 237
1400 Independence Road
Rolla, Missouri 65401

Figure 1
Digital Raster Graphic (DRG) availability

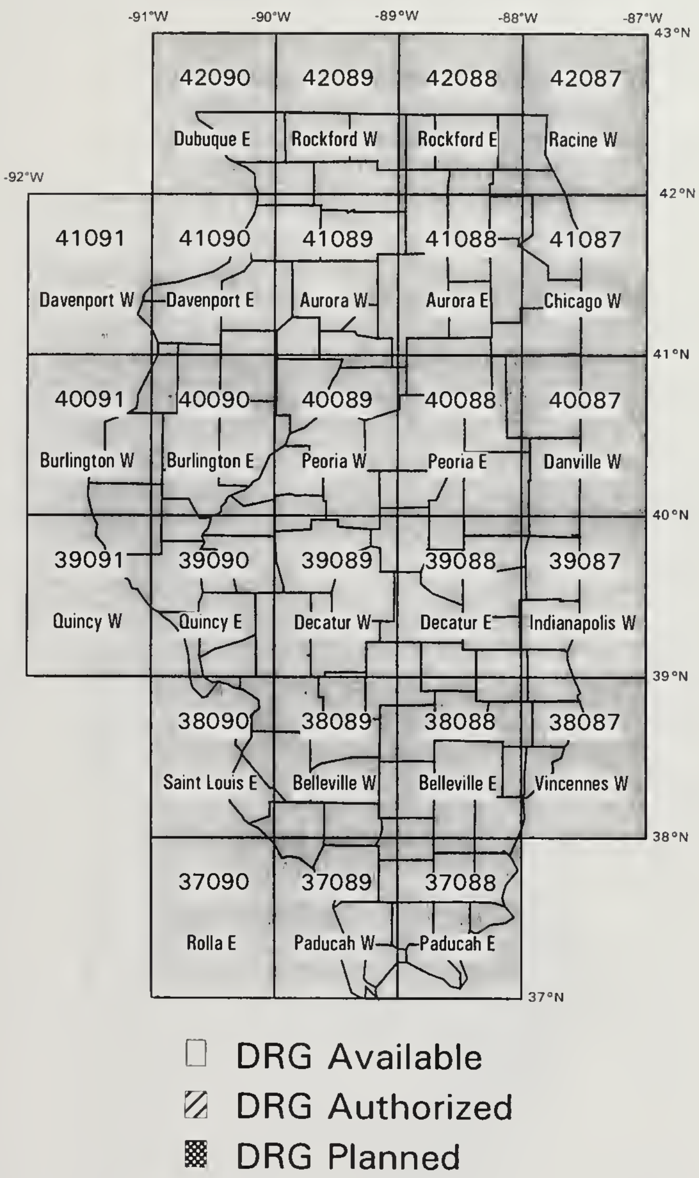


Figure 2
Digital Orthophoto Quadrangle (DOQ) availability
1:12,000 scale

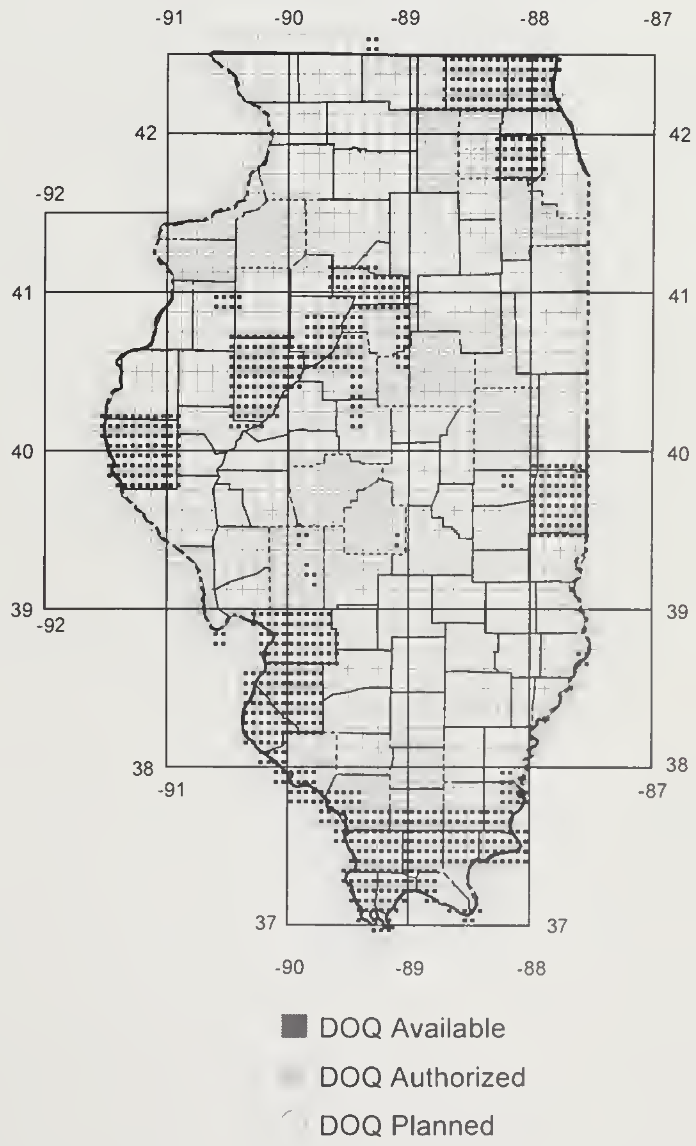
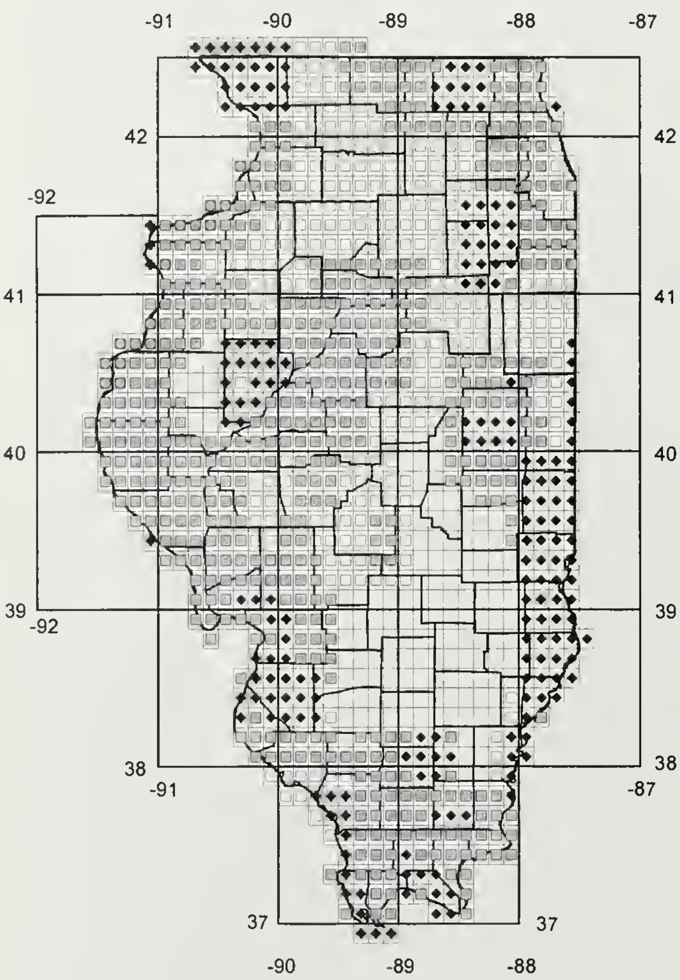
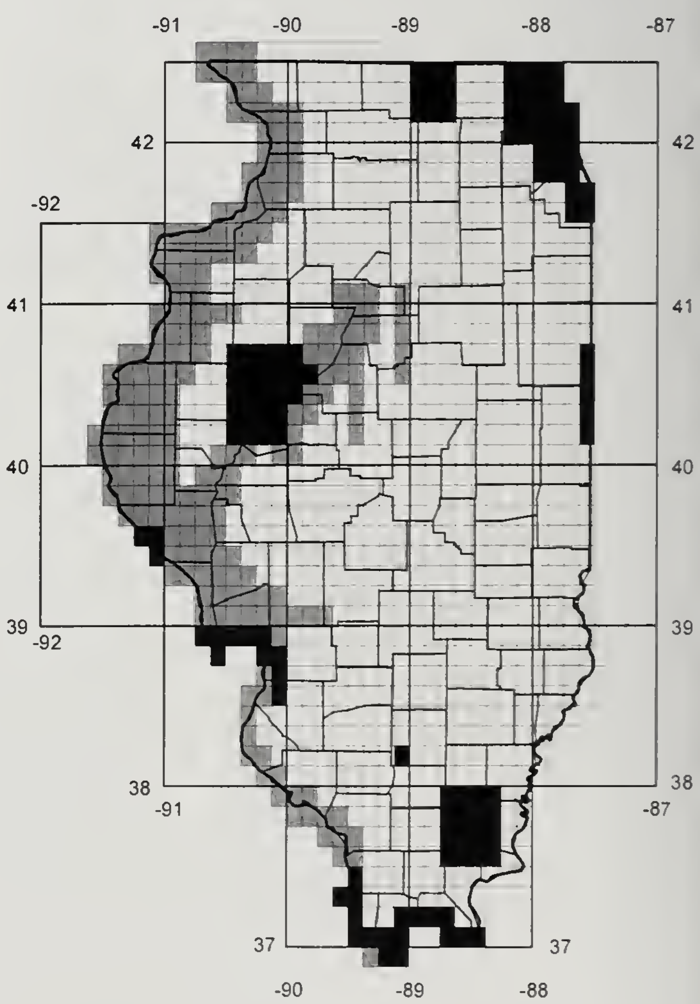


Figure 3
Digital Elevation Model (DEM) availability
7.5-minute series



DEM Available
Level 2, 7m vertical accuracy
● 10m Posting (Not Currently Available)
□ 30m Posting
Level 1,7m vertical accuracy
◆ 30m Posting
Level 1, 15m vertical accuracy
★ 30m Posting
DEM Authorized for production
Level 2, 7m vertical accuracy
○ 10m Posting
□ 10m Posting

Figure 4
Digital Line Graph (DLG) availability
7.5-minute boundary overlay



Boundaries Available
Boundaries Authorized

Figure 5
Digital Line Graph availability
7.5-minute public land survey system (PLSS) overlay

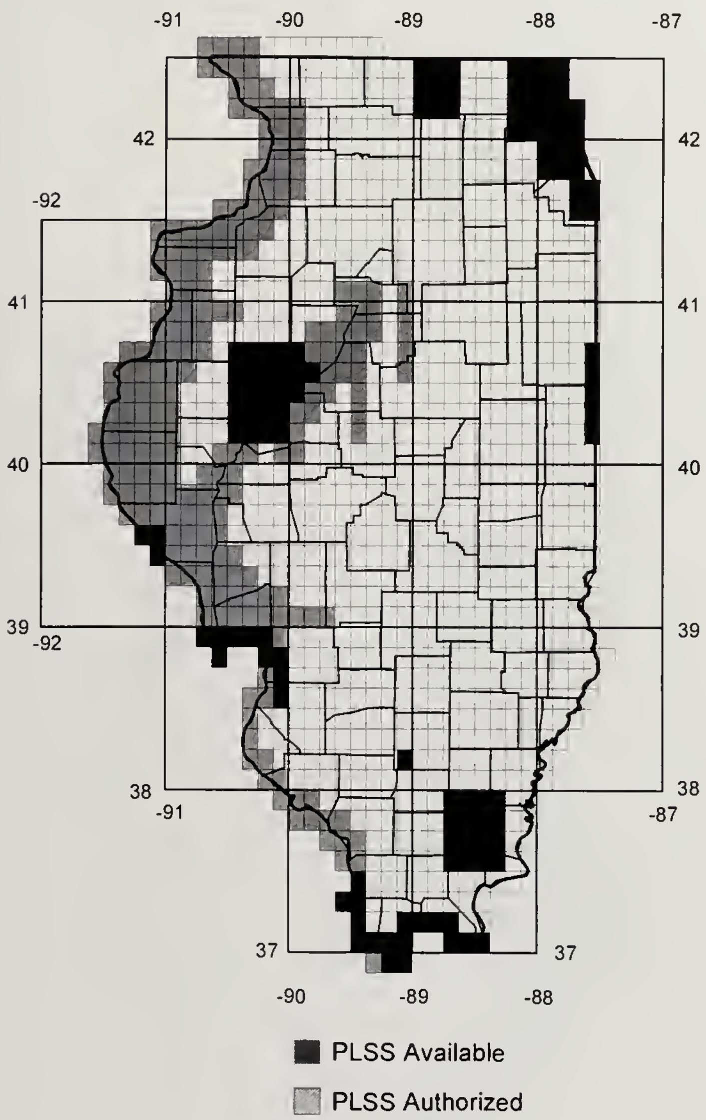


Figure 6
Digital Line Graph availability
7.5-minute hypsography (contours) overlay

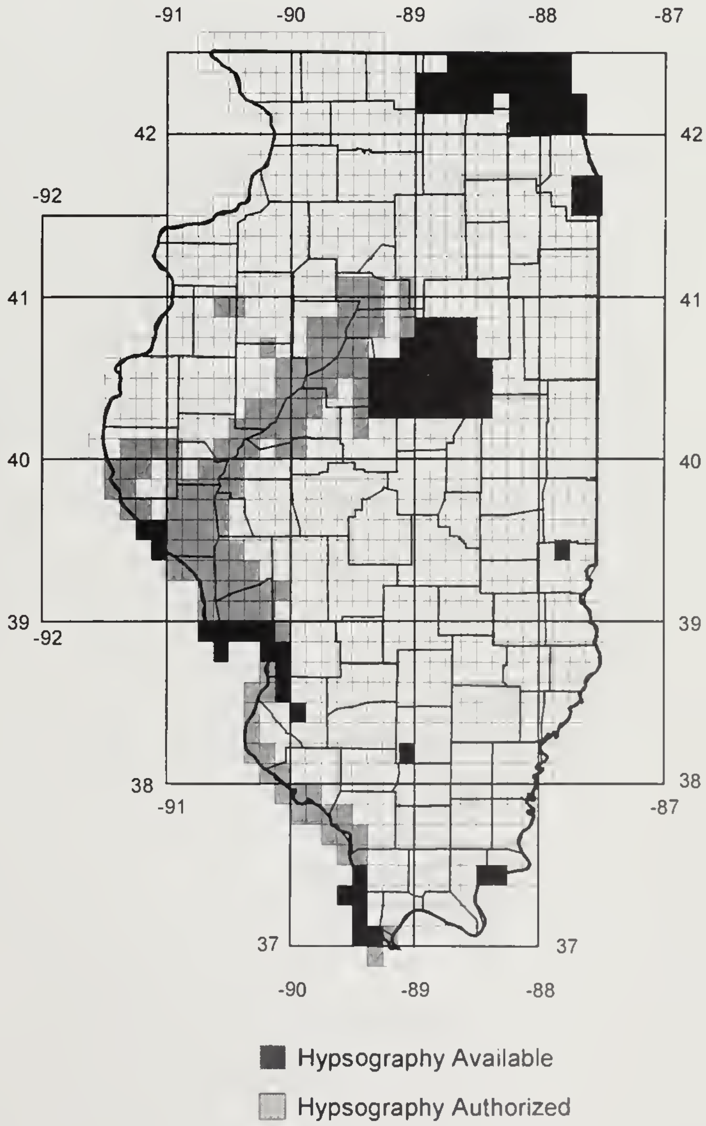


Figure 7
Digital Line Graph availability
7.5-minute hydrography overlay

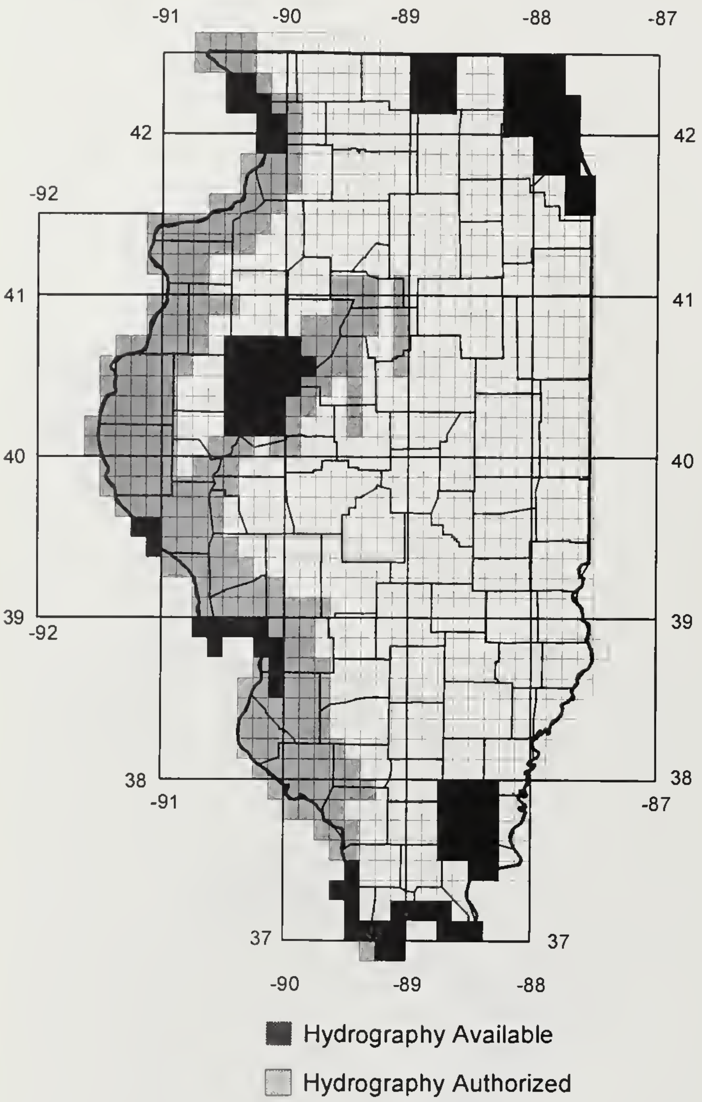


Figure 8
Digital Line Graph availability
7.5-minute transportation overlay

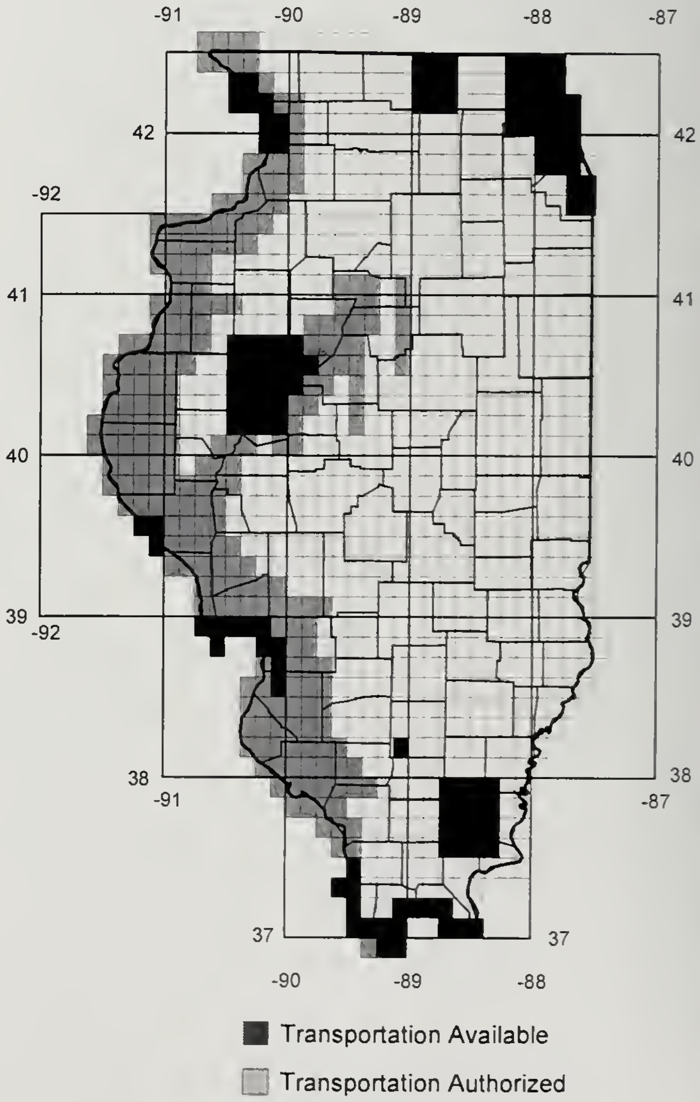


Figure 9
Digital Line Graph availability
7.5-minute miscellaneous culture overlay

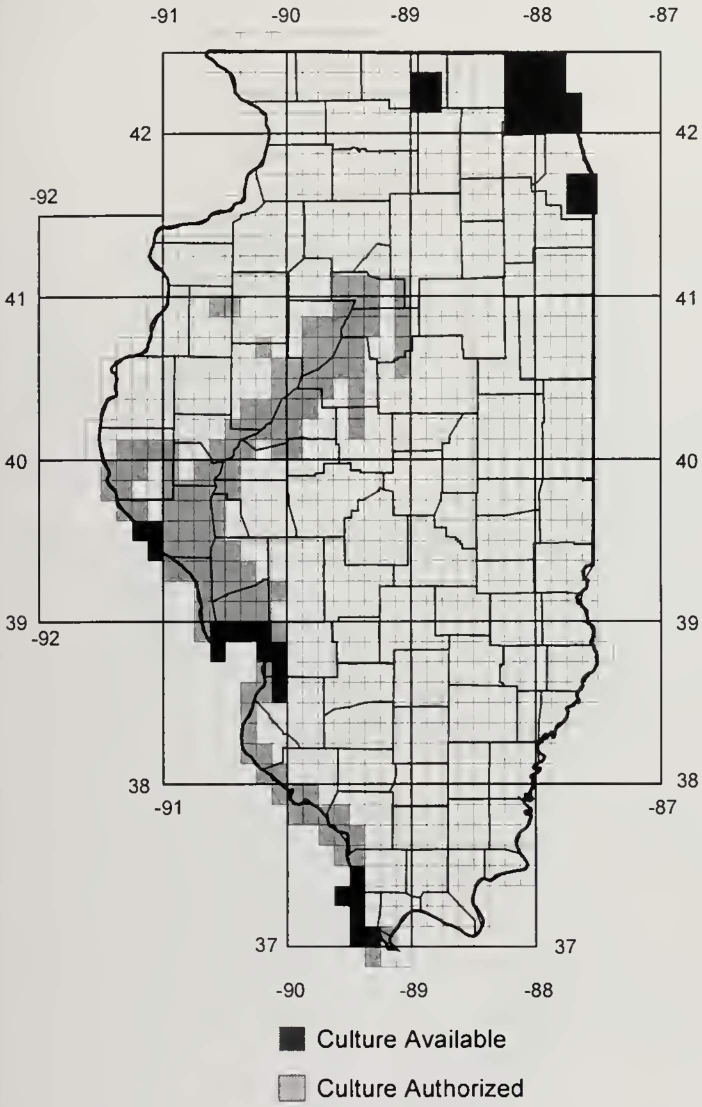


Figure 10
Digital Line Graph availability
7.5-minute survey control overlay

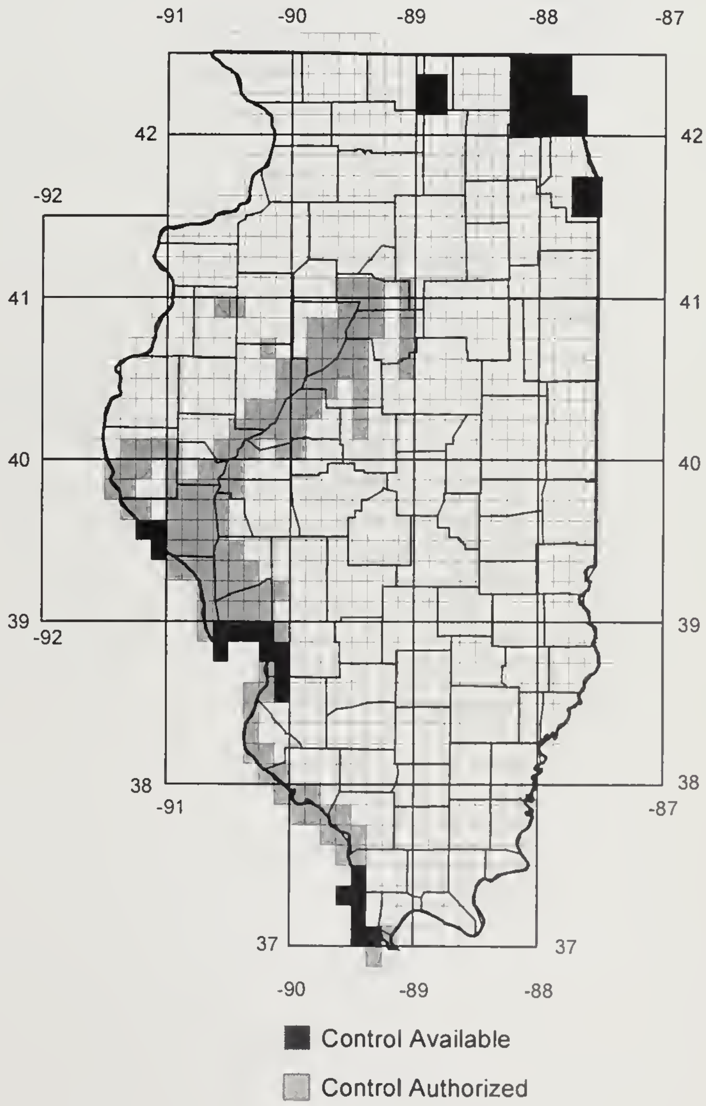


Figure 11
Digital Line Graph availability
7.5-minute vegetation overlay

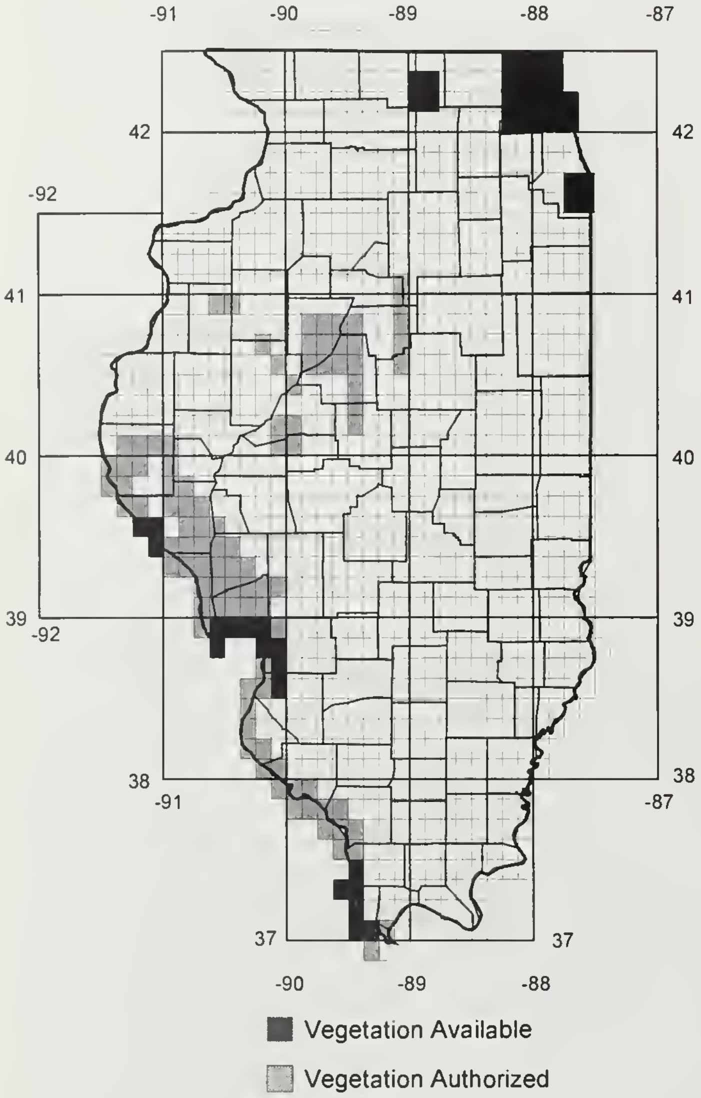
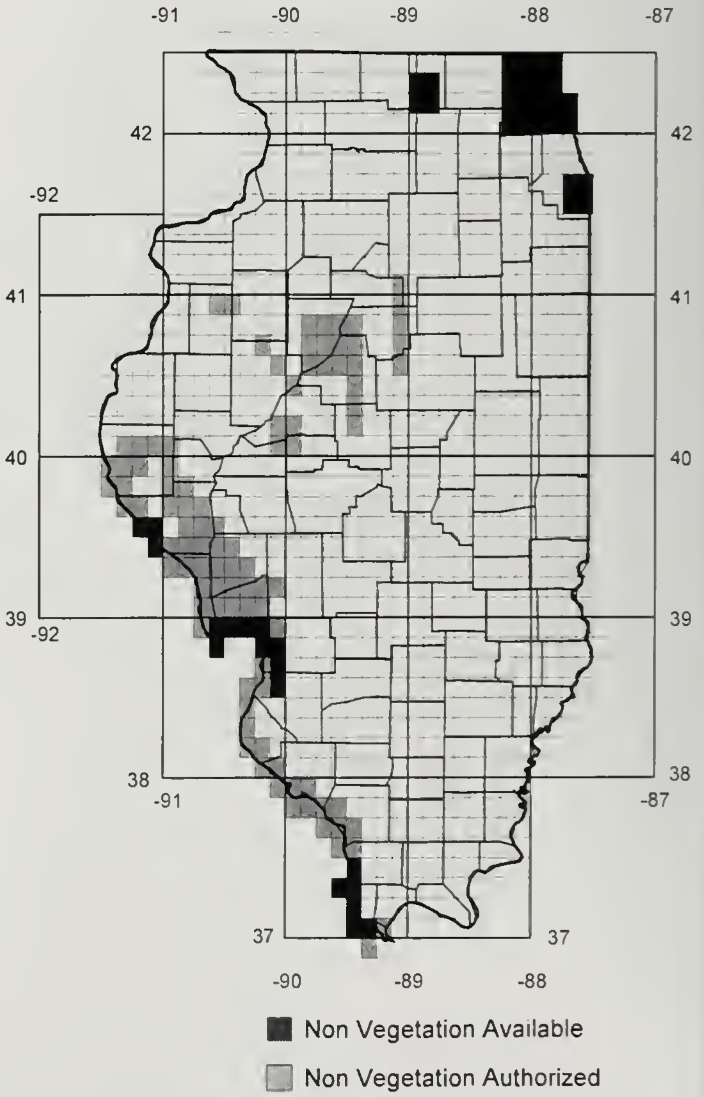


Figure 12
Digital Line Graph availability
7.5-minute nonvegetation overlay



U.S. Fish and Wildlife Service

Mike Johnson
U.S. Fish and Wildlife Service
Barrington, Illinois

The U.S. Fish and Wildlife Service has a strong presence in Illinois. The service fulfills its mission through two Ecological Services Offices, seven Refuges, three Law Enforcement Offices, and a Fisheries Assistance Office — all located in Illinois.

McHenry County Advanced Identification Study

The Chicago Field Office is currently assisting in an Advanced Identification study (ADID) for McHenry County. The purpose of such a study is to identify in advance all of the high-quality wetlands in a geographic area. Such wetlands are not likely to be "suitable for filling" under a permit stipulated by Section 404 of the Clean Water Act. All the wetlands in the county were identified and mapped by the Natural Resources Conservation Service of the U.S. Department of Agriculture, which provided the data to the U.S. Environmental Protection Agency (USEPA) in digital format. The USEPA assembled a local team of resource professionals who will evaluate all of the county's wetlands for their natural character, size, degree of disturbance, importance for storage and/or groundwater recharge, and biological functions. Once the inventory and evaluation is completed, the entire McHenry County ADID wetland inventory will be put into a GIS system by the Northeastern Illinois Planning Commission (NIPC). The information will be transferred to CD-ROM, and NIPC will make it available to county, state, and local governments as well as agencies.

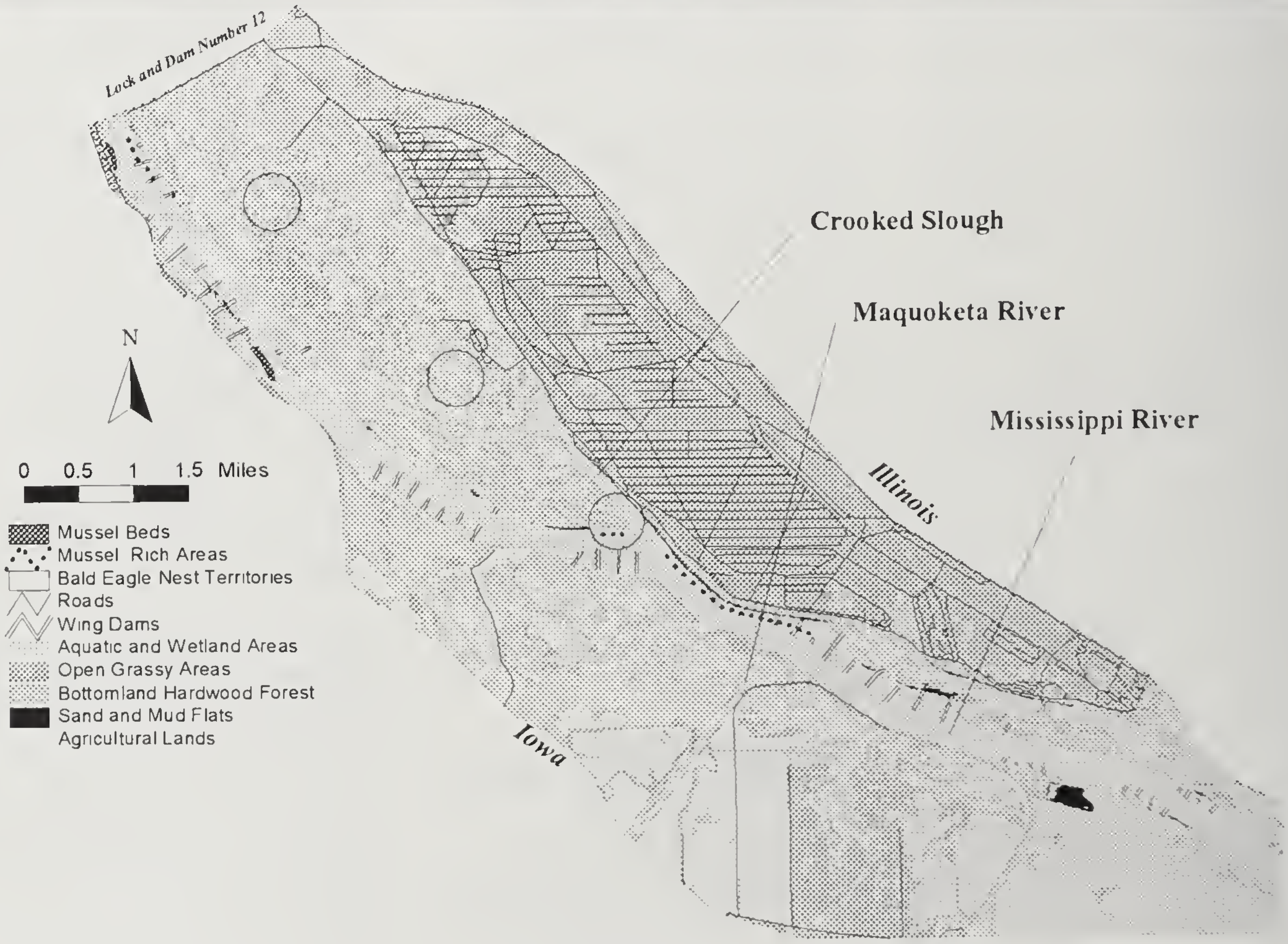
Savanna Army Depot, Jo Daviess and Carroll Counties

Several state and federal projects at the Savanna Army Depot use GIS analysis for natural resource planning (Figure 1). The projects include development of wildlife management plans, hazardous waste clean-up, relocation of base mission, and base closure. This was a cooperative GIS effort with assistance from the U.S. Army, Augustana College (Rock Island, Illinois), the Illinois Department of Natural Resources, the U.S. Army Corps of Engineers, and the U.S. Fish and Wildlife Service. A GIS was used to map the locations of endangered species and sensitive habitats. The spatial data helped the action agencies with endangered species consultation.

Rock River Special Area Management Plan, Henry and Rock Island Counties

A GIS was used to reclassify and illustrate wetland quality in the floodplain of the Rock River near Milan and Rock Island. Field personnel from the National Resource Conservation Service, U.S.

Figure 1
Mississippi River Pool 15, Savanna Army Depot Area



Army Corps of Engineers, Illinois Department of Natural Resources, and U.S. Fish and Wildlife Service verified wetland location and status. The field information was entered into a GIS database by students from Augustana College under supervision of the Quad Cities BiState Commission. The resulting maps were placed in an atlas for use by city and county planners as they consider development of the Rock River floodplain areas.

For more information about these projects and other activities of the U.S. Fish and Wildlife Service in Illinois, contact:

Richard Nelson
Field Officer Supervisor
Rock Island Field Office
4469 48th Avenue Court
Rock Island, Illinois 61201
309.793.5800, ext. 519

John Rogner
Acting Field Supervisor
Chicago Field Office
1000 Hart Road, Suite 180
Barrington, Illinois 60010
847.381.2253

Updates — State Agencies

Illinois Department of Transportation

James Hall
Illinois Department of Transportation
Springfield, Illinois

Geographic Information System (GIS) technologies provide the potential to enable many operational efficiencies in the Illinois Department of Transportation (IDOT). Rapid technological advances in GIS software and plotting capabilities have enabled the use of GIS for decision making and analysis at a multitude of organizational levels. GIS for Transportation (GIS-T) is a rapidly evolving field and represents highways, transportation networks, and other geographically referenced attributes for transportation decision making.

The magnitude of the 138,000-mile Illinois highway network, 25,900 structures, and 9,800 railroad crossings, combined with multiple organizational uses and the need for accuracy, have resulted in a high degree of complexity in implementing a GIS. Therefore, IDOT has methodically planned implementation over a long time frame as an organization-wide endeavor.

To date, IDOT has generated a computerized roadway network from the 1:64,000-scale county map series. Scanned county maps provided the base to create a series of links and nodes that represent the roadway network. This link/node base encompasses all state, county, township, and nonresidential municipal streets representing approximately 111,000 miles. IDOT is currently evaluating methods to incorporate the 27,000-mile residential street network.

This link/node base acts as the framework to attach geographically referenced information. IDOT is in the process of attaching road, structure, and railroad crossing inventory information using Arc/Info software and is conducting an extensive data verification process before making GIS information available to outside agencies.

The GIS is in the initial stages of production. IDOT plans to use GIS technology in a variety of ways including general mapping and display, program development, emergency routing, and accident analysis. GIS provides a powerful means to integrate information from disparate data sources. Of special interest is the ability to generate ad hoc reports in response to queries. All organizational areas within the Department of Transportation have been solicited to determine the scope of GIS-related products and their quantifiable benefits.

IDOT is developing a display of winter road conditions on the internet using GIS. This display will be available on the department's home page at *http://www.dot.state.il.us* for the 1997-98 winter driving season.

Figure 1
Winter Road Conditions
January 11, 1998, 10:30 PM

If you would like further information on the department's GIS-T, please contact James Hall at 217.785.2998.

Illinois Geographic Emergency Management System

Patrick Keane
Illinois Emergency Management Agency
Champaign, Illinois

The Illinois Emergency Management Agency (IEMA) is heading in a new direction with its use of geographic information system technology. By way of explanation, a GIS is a computer-based information management system that couples information (data) with geography (maps). When the information is displayed spatially as a map, analysts are better able to explore the relationships between multiple sets of data.

Background

For several years the agency's GIS format has been Atlas GIS. Although this format is still available, data transfer and compatibility problems have led the IEMA to adopt ArcInfo/ArcView from ESRI as its new GIS platform. Although this change in platforms necessitates the conversion of data already held by IEMA to a different format, it is believed that the new software will accomplish two critical objectives. First, it will increase IEMA's ability to perform complex spatial analysis, to display data and imagery, and to produce usable disaster intelligence support products during disaster response and recovery operations. Second, it will provide greater compatibility with the information and GIS formats of other state agencies.

GIS Project Goals

In order to enable GIS to be more fully integrated into the areas of planning, analysis, response, and recovery, the Illinois Emergency Management Agency has recently established a special GIS project within the Information Technology Section of the agency. The mission of the IEMA GIS Project is to provide timely, integrated geographical and spatial data, analysis, imagery, and decision support information to enhance disaster mitigation, preparedness, response, and recovery activities.

Project Components

The first major component of the project is to convert current agency information into relational database files. Currently the agency has a great deal of information, but, unfortunately, much of it is in various paper or text formats, which have limited functionality within a GIS-based information management system. With a conversion of the information to database format, and with geocoding of the information (assigning a latitude and longitude to it), the data will be linked directly to the computer-generated maps.

The second major component of the GIS project is to enhance the response capabilities of the agency through the use of GIS. In order to support emergency and disaster

operations, two types of read-only base maps, a statewide map and individual county maps, are being prepared for immediate use in the response phase of a disaster. The statewide basemap, with spatial data acquired at a scale of 1:100,000, will give a general overview of geographical information within the state, as well as information which is vital to response (airports, levee districts, hospitals, etc.). As the user zooms in to a location on the map for a closer look at a specified area, the map scale will automatically change to show greater detail such as county highways, political boundaries, and municipalities.

The 102 individual county base maps, with data ranging in scale from 1:100,000 to 1:24,000, will still have the general geographic information as found on the statewide map, but they will also show information which is specific to each county (e.g., county roads, streets, county parks, critical facilities, etc.) Both the statewide and individual county base maps will give the State Emergency Operations Center, the State Forward Command Post, and the Recovery Team a solid foundation of spatial information from which to formulate both strategic and tactical plans of action. As the response gets underway and more disaster-specific data becomes available, the new information will be integrated with the basemap information to give an accurate view of the disaster in real time.

Distributive Databasing

In order to ensure the timeliness and accuracy of information, IEMA is entering into distributive database agreements with many other state agencies for the purposes of information management. The distributive database concept allows IEMA to acquire critical information from other agencies, geocode the information, and return it to the original agency. They will keep the information current by providing annual updates, and at the time of a disaster impact, they will file transfer the most current version of the data to IEMA. This will not only allow for greater planning and analysis capability within the agency, but will also provide an efficient method to simultaneously update both the information and the maps.

Project Future

At the conclusion of the initial data conversion phase of the project, the statewide and individual county base maps and their associated information will be written to CD-ROM. This project will be shared with other state GIS users and with interested county and local Emergency Service Disaster Agencies that are capable of using information formatted with Arc/Info.

Illinois Environmental Protection Agency

Wally Hartshorn and David Mick
Illinois Environmental Protection Agency
Springfield, Illinois

The Bureau of Air of the Illinois Environmental Protection Agency (IEPA) uses GIS for several activities. One use is supporting the agency's air pollution modeling program. Agency staff perform extensive modeling to document the levels and distribution of air pollutants and to develop strategies to control and reduce the levels of these pollutants. GIS allows staff to go beyond the outputs of the standard models to show how locations may be affected and to provide easier viewing of graphical representations, among other benefits.

GIS was used in support of the program to expand the Vehicle Inspection and Maintenance Program in the Chicago and East St. Louis areas. The agency prepared maps showing the existing areas in the program and then developed a number of "what if" scenarios to arrive at the present expanded program. GIS provided the ability to respond rapidly to changes in the area proposed by the public and by government officials and to produce maps so that everyone knew exactly what these changes involved. GIS was also used to create maps showing relationships between monitoring sites, emission sources and cultural and topographic features.

The Bureau of Land is developing a GIS to integrate its databases and augment analyses of groundwater and leachate data from waste facilities regulated by the Permit Section. The GIS database integration began with the conversion of three databases maintained on mainframe computers into Arc/Info: (1) the Groundwater Quality Database containing over 2.5 million records from facilities with long-term groundwater and leachate monitoring; (2) the Inventory Database primarily containing location information about facilities; and (3) the USEPA RCRIS database of permit data from Illinois EPA–regulated hazardous waste facilities. To complete this phase of database integration, staff converted Permit Section databases containing permit history and status to dBASE format. These databases can now be accessed by ArcView.

Point coverages, which identify the geographic location of waste facilities in the databases, were created. Two additional statewide point coverages were created for facilities with long-term groundwater and leachate monitoring: (1) currently permitted hazardous waste sites and interim status filers; and (2) landfills. Large-scale coverages of select facilities were also created. The large scale coverages identify the location of monitoring and leachate wells, waste units, and facility property. Attributes for the coverages are derived from the databases that have been integrated into the GIS.

The GIS has been utilized to perform analyses that were not previously possible or practical. The large-scale coverages of individual facilities and the Arc/Info GRID module are utilized to spatially analyze groundwater quality and hydraulic information contained in the groundwater quality database. The effects of proposed legislation for landfill siting have been analyzed with the GIS. Another application of the GIS has been to develop facility performance evaluations. The initial evaluation was a pilot study of the performance and ranking of 11

permitted facilities for maintaining groundwater quality. The study was completed utilizing the SQL and relational database features of Info and Mathsoft S-Plus software. The procedures developed from the pilot study will be automated for future evaluation of permitted hazardous waste sites.

Expansion of the GIS is advancing to the personal computer of the individual permit reviewer. A customized project is being developed in PC-based ArcView that will utilize Server Message Block (SMB) software to access Arc/Info databases and coverages stored on a Sun workstation. Additional developments will include an intranet utilizing the Internet Map Server extension to make the GIS available to users without ArcView.

GIS will continue to play a major role in enhancing the Surface Water Monitoring Programs of the Division of Water Pollution Control, facilitating the division's ability to integrate data more effectively in a manner consistent with the need for a watershed-focused approach to water quality management and ecological health.

Two GIS coverages are at the core of the division's GIS activities, a polygon coverage and a line coverage. The polygon coverage consists of the topographic drainage area of each stream water body identifier contained in Illinois EPA's "Illinois Water Quality (305(b)) Report." The line coverage consists of a subset of USEPA's Reach File 3 (RF3). This subset of RF3 includes the streams and lakes assessed in the 305(b) report.

Numerous federal and state activities revolve around these two primary coverages. These activities include: water quality assessments for the 305(b) report; identification of waters targeted for Total Maximum Daily Load (TMDL) development through the 303(d) process; the Targeted Watershed Approach process, which expands the scope of geographic targeting under the 303(d) process to include preventive measures; the coordination of watershed priorities between agencies; and the verification of indicators utilized in the Index of Watershed Indicators (IWI) process by USEPA.

GIS goals for the future include the development of GIS coverages and database links to more effectively integrate additional information into the Bureau of Water's decision making matrix. Examples of some of these coverages to be developed include: facility-related stream survey reaches; effluent-modified waters; disinfection-exempted waters; waters used as public water supplies; and swimming use waters.

The Division of Public Water Supplies is currently working on a number of initiatives designed to provide a comprehensive spatial data infrastructure for implementation of groundwater and surface water protection activities within the state of Illinois. Division staff are currently developing 1:24,000-scale datasets depicting the locations of community water supply (COOS) wells and intakes, minimum and maximum setback zones, and delineated wellhead protection areas. In addition, potential contamination source inventories compiled on 1:4,800-scale aerial photographs are being converted into digital format.

Illinois Department of Natural Resources Office of Realty and Environmental Planning

Sheryl Oliver
Division of Energy and Environmental Assessment
Springfield, Illinois

The Illinois Department of Natural Resources (IDNR) is broad in scope, multifaceted in mission, and multidisciplinary in program orientation. Comprised of ten offices, IDNR houses one of the oldest and largest distributed GIS installations in the state, a product of the former Department of Mines and Mineral's "Lands Unsuitable for Mining Program." The State Scientific Surveys along with the Waste Management and Research Center located in Champaign and the Illinois State Museum located in Springfield embody a widely acclaimed GIS resource. Separate updates are provided in this issue of *Mapnotes* focusing on their individual efforts.

Four offices in Springfield are now implementing GIS in various capacities: Realty and Environmental Planning; Resource Conservation; Mines and Minerals; and Capitol Development. In addition, the encompassing Conservation 2000 Program, administered in Springfield, uses GIS in a wide range of projects. The following is a brief description of some GIS activities at DNR-Springfield.

Conservation 2000 Program

The largest Conservation 2000 program works with local partnerships of citizens (22 to date) who are concerned about the condition of resources within their local watersheds to address environmental issues throughout the state. In order to characterize, understand, and evaluate the condition of resources within local watersheds, it is important to glean a spatial perspective by gathering and maintaining geospatial information that is reliable, accessible, and consistent. A GIS initiative is underway to help partners achieve this. Through Conservation 2000 the first wave of existing partnerships has received a small GIS installation, which includes hardware, software, digital geospatial datasets, and training in software and metadata. Filling gaps in data is a tedious process, but, as partners develop new digital geospatial data, it will be done using standards and protocol that will enable joint databases to be developed, shared, and transferred efficiently. Clearly, as new data converge, so too does the confluence of our watersheds.

GIS Day-to-Day

Office of Realty and Environmental Assessment. Several divisions are involved in GIS facilitation in the Department of Natural Resources. The Division of Energy and Environmental Assessment is focusing on database development. Project-specific applications include Conservation 2000 and critical trends assessment. In the Division of Natural Resources review and coordination efforts center on an initial review of proposed residential and commercial development and the environmental impacts of such development. The Division of Planning has implemented the digital development of the massive "Illinois Recreational Facilities Inventory." In collaboration with the Illinois State Museum, the Division of Planning is involved in archeological site protection and management.

Office of Mines and Minerals. The Division of Land Reclamation is assessing the environmental effects of mining in the permit applications review process. The division provides technical support to other offices at DNR as well as technical web site support.

Office of Resource Conservation. The Watershed Management Program uses GIS for coordinated watershed planning. Database development and maintenance is an ongoing activity. The program provides overall GIS training and support to the Office of Resource Conservation.

Office of Capitol Development. The Division of Engineering provides project review and management for sites in the Capitol Development Program.

Illinois Department of Natural Resources Office of Scientific Research and Analysis

Mark Joselyn
Illinois Natural History Survey
Champaign, Illinois

In cooperation with the USGS-Biological Resources Division, the following statewide databases are currently under development at the Natural History Survey:

- Creation of a vegetation community map from satellite imagery.
- Creation of vertebrate distribution maps and corresponding habitat relationship models for all vertebrates in Illinois.
- Creation of a comprehensive public lands database including federal, state, and county lands.

The IDNR Critical Trends Assessment Program (CTAP) is an ongoing effort to monitor the condition and extent of Illinois's ecosystems. Current GIS activities of the Natural History Survey in support of CTAP include:

- Updating the Land Cover Map of Illinois on a four-year rotating cycle. The western part of the state is to be completed by June of 1998 based on imagery acquired in the spring and fall of 1997.
- Support of long-term professional monitoring of wetland, forest, stream, and grassland habitats in Illinois. This includes random selection of sampling sites, georeferencing of data collection sites using global positioning technology, development of data dictionaries, and map generation.
- Generation of landscape-level maps for Ecosystem Partnerships throughout Illinois. Currently there are 21 such partnerships.
- Analysis of trends in bird populations based on Breeding Bird Survey data.

Other INHS activities include:

- The Illinois Natural Areas Inventory, originally digitized by the Natural History Survey in the mid-1980s from aerial photography, is being improved so that all boundaries are mapped at a scale of 1:24,000. This work is being done with the assistance of IDNR's Division of Natural Heritage.
- GIS is being used to characterize regions within Illinois based on their potential for restoration of large grassland habitats. This information will be used to guide field work and future restoration efforts.
- Georeferencing of aquatic collections, mollusks, crustaceans, and fish is nearing completion. Maps of sampling locations can be viewed on the internet at *http://www.inhs.uiuc.edu/cbd/collections/*
- The use of Global Positioning Systems (GPS) continues to grow within the Survey. Numerous training workshops have been held with over 30 staff completing a two-day course in use of GPS units. Survey staff are currently working to establish an Illinois base station at the University of Illinois campus which will increase positional accuracies.
- Racoon movements were monitored using radio collars and telemetry over a two-year period in a study area near the Middle Fork of the Vermilion River. These data were used in conjunction with land cover information based on rectified aerial photography. GPS was used to locate telemetry stations, and GIS was used to generate information on habitat use and proximity to edges. These data are currently being analyzed.
- The Natural History Survey is working with other divisions within IDNR to coordinate the movement of existing GIS databases to the North American Datum (NAD) of 1983. This is required to improve positional accuracy and to make existing data compatible with information gathered via GPS.

This report was compiled through contributions by the following Natural History Survey staff: Jocelyn Aycrigg, Kate Hunter, Mark Joselyn, Tom Kompare, Tony McKinney, and Liane Suloway.

Illinois Department of Natural Resources Office of Scientific Research and Analysis

Robert Krumm
Illinois State Geological Survey
Champaign, Illinois

The Illinois State Geological Survey (ISGS) uses GIS technology to support a number of geologic mapping projects and to respond to requests from other governmental agencies, the general public, and the private sector. Recent efforts have focused on the compilation of GIS databases for detailed and regional geologic mapping projects as well as on an effort to serve digital geospatial databases on the internet.

Illinois Geologic Mapping Program

The ISGS has implemented this program to increase the production and distribution of detailed geologic maps and digital geologic databases. This work will be completed at a scale of 1:24,000, based on the USGS 7.5-minute quadrangles. The Vincennes (Lawrence County) and Villa Grove (Douglas County) quadrangles were selected as pilot projects, and many map products are being generated for those areas including land surface images (digital orthophoto quads), geologic materials at the land surface, thickness of glacial deposits, bedrock topography, geologic map of the bedrock surface, coal resources, aquifer sensitivity, cross sections, and 3D volume models of the subsurface geology. Four areas of the state have been identified for detailed geologic mapping this year, including Adams, Henry, Peoria, and St. Clair Counties, and these areas will serve as centers for future mapping efforts.

Geologic Maps of Counties in Illinois

Funded by the Illinois Department of Commerce and Community Affairs, the focus of this project is to provide new geologic maps and digital geologic databases to counties to help support long-term planning concerns such as solid waste disposal. During the last year maps have been delivered to McLean and Carroll Counties, and data compilation and field work have started for Lee and Jo Daviess Counties. Geologic maps and digital databases are available for portions of Lake and Will Counties.

With funding from the USGS STATEMAP program, ISGS staff have compiled detailed geologic information for southern and central Henry County. Detailed geologic maps of Henry County (at a scale of 1:24,000) have been prepared by Richard Anderson of Augustana College. The goal of this project was to digitize Anderson's maps to produce new 7.5-minute geologic maps and a 1:100,000-scale compilation map showing the geology of Henry County. A similar effort to digitize geologic maps for Whiteside County will begin this year.

National Spatial Data Infrastructure (NSDI) Node

ISGS staff have established an internet site to serve GIS data and associated metadata (documentation) about Illinois natural resources. The NSDI develops policies, standards, and procedures for organizations across the country to cooperatively produce and share geospatial databases. This project is a cooperative effort that involves several divisions and offices within DNR. More information is available on the internet at *http://www.isgs.uiuc.edu/isgsroot/isgshome/fra3.htm*

For additional information, please contact:

Robert Krumm
Illinois State Geological Survey
615 East Peabody Drive
Champaign, Illinois
217.333.4085
krumm@geoserv.isgs.uiuc.edu
ISGS home page *http://www.isgs.uiuc.edu/isgshome.html*

Illinois Department of Natural Resources Office of Scientific Research and Analysis

Kingsley Allan
Illinois State Water Survey
Champaign, Illinois

The Illinois State Water Survey (ISWS) recently added to its GIS data scanned topographic map sheets from the U.S. Geological Survey (USGS) for the entire state of Illinois. This database was derived from the Digital Raster Graphic (DRG) files which the USGS began publishing in the spring of 1995. The 1:24,000-scale paper maps were scanned and stored in a TIFF format. Each digital sheet has a file of georeferencing information with which each DRG displays at the correct position and scale using GIS software. The DRGs can be used as a background to existing GIS data such as flood zones. DRGs for the entire state of Illinois became available in the spring of 1997.

The Illinois State Water Survey purchased and then processed the 1,072 DRGs to improve their utility within GIS. First, the border areas, which include legends, titles, and scale bars, were digitally "trimmed" from each map so that neighboring DRGs could be displayed side by side. Second, the coordinates of the DRGs were changed from the UTM projection to the Lambert Conic Conformal projection, which is a standard at ISWS, and therefore matches other ISWS GIS data. This change was beneficial because it allowed all sheets to be displayed together. Such a display would otherwise have been impossible because the USGS uses two different UTM zones for Illinois. In the third step of processing, the datum of the twelve DRGs with a datum different from the remainder was standardized to NAD27. This change ensured that sheets could display side by side without data gaps. Fourth, a small strip of data from the four neighboring sheets was added to each sheet, thereby creating a small overlap between sheets. This change was made to compensate for a printing quirk in the GIS software which requires DRGs and other image data to be rectangular in shape aligned north-south (DRGs are slightly tilted). Finally, the names of the DRGs were changed to match an indexing system used by ISWS and a few other agencies.

Although the DRGs can be displayed in a GIS, they do not have associated attribute databases. In other words, the user cannot click on a feature on the DRG such as a lake, and have the name and size of the lake automatically displayed or use the size later in calculating total lake area in a particular county. However, the user can trace features appearing on the DRGs using the mouse and build new GIS databases with full query and analysis functionality. This is known as onscreen digitizing.

The ISWS is making this database available on CD-ROM. DRGs for the entire state require approximately nine gigabytes of storage, so ISWS is storing them on more than one CD-ROM; in fact, the USGS split the state up into 27 CD-ROMs. The ISWS split them up according to 12 subregions of the five administrative regions of the Department of Natural Resources (DNR), of which ISWS is part. DRGs that overlap county boundaries will be on more than one of the 12 CD-ROMs. The CD-ROM also contains metadata, index maps, and the ESRI ArcExplorer GIS Software for viewing the DRGs.

The Data and Information Systems Management group includes: Kingsley M. Allan, Kathy Brown, Ravi Duuvuri, Cesar Hernandez, Tangie Jones, Jacob Krimbel, Troy Lively, Lorna Morgan, Bob Sinclair, Gana Ramamurthy, Ben Varner, and Doug Ward. Please direct your inquiries to:

Kingsley M. Allan
Illinois State Water Survey
2204 Griffith Drive
Champaign, Illinois 61820
Phone 217.333.0545
Fax 217.333.6540
k-allan@uiuc.edu
http://www.sws.uiuc.edu

Illinois Department of Natural Resources Office of Scientific Research and Analysis

George Krumins
Waste Management and Research Center
Champaign, Illinois

Since Illinois is a diverse state, resource-rich but heavily industrialized in some areas, the need for current environmental information on hazardous and toxic waste is critical. GIS at the Waste Management and Research Center (WMRC) provides individuals, companies, and state agencies with essential geographically referenced information on the locations of waste generators, waste management facilities, contaminated sites, and the quantities and components of hazardous materials through the use of computer-based technologies and databases.

Integrating ESRI GIS, Oracle RDBMS (relational database management system), and other software tools, environmental reports are produced that range from a simple report on a single landfill site to an in-depth year-by-year look at the types and quantities of Toxics Release Inventory (TRI) chemicals produced by manufacturing facilities in watersheds.

Two reports are frequently requested by environmental firms conducting preliminary and Phase 1 assessments, in accordance with the Illinois Responsible Property Transfer Act. If buyers of real estate exercise "due diligence" and they buy contaminated property, they might possibly avoid the potentially devastating costs of remediation. This means that if buyers conduct an environmental assessment or review of the property's past uses prior to acquiring title, they may not be culpable.

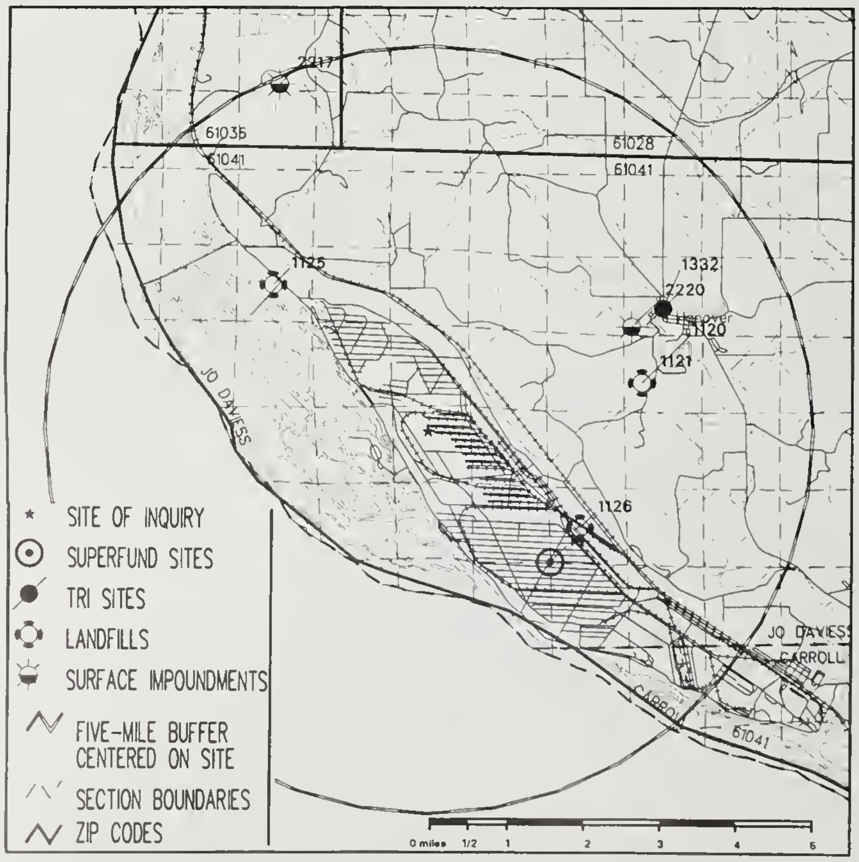
The first report is the Historical Hazards report. Looking back in time before the 1970s, a window is opened onto historical industrial practices from 1887 to 1950, before federal environmental laws constructed a manifest system that regulated hazardous materials. These data were interpreted and digitized from the Sanborn fire insurance maps. Coupled with research into historical industrial practices and occupational health literature, the data identify urban sites that may still be affected by hazardous materials. This report includes a map and tabular report detailing the sites shown.

The other report is the Database zip code report. This report includes information from a number of databases including CERCLA (Superfund, which includes the NPL — National Priority List), Landfill, and Surface Impoundment Inventory databases, grouped by zip code. A nominal fee is charged for both these reports in order to recover some of the cost of development and maintenance.

All these databases are source material currently used in writing area assessments for the Critical Trends Assessment Project (CTAP). This project is an on-going effort to assess ecological conditions in Illinois and provide information for ecosystem-based management, and it provides scientific support to Conservation 2000, a comprehensive, six-year, $100 million initiative which addresses the natural resource needs of Illinois into the 21st century and beyond.

So, for environmental reports regarding hazardous and toxic waste in Illinois, look to WMRC GIS.

Figure 1
Zip codes, superfund sites, landfills, and surface impoundments in 100 square miles centered on the Savanna Army Depot



Illinois Department of Natural Resources Office of Scientific Research and Analysis

Erich Schroeder
GIS Laboratory, Illinois State Museum
Springfield, Illinois

Geographic Information System (GIS) capability and applications are integral to many Museum databases and programs. Arc/Info and Arcview are used for modeling, map production, and map display for a wide variety of Museum programs ranging from research, to cultural resource management, to collections, to exhibitions, and other educational programs. Recent projects of the Museum's GIS Laboratory can be reviewed on the Museum's World Wide Web site *http://www.museum.state.il.us/research/GISlab/index.html.*

The Museum developed, maintains, and regularly uses a number of GIS-based databases: National Quaternary Mammals Database (funded by the National Science Foundation); Illinois archaeological sites and other historical features (standing structures and cemeteries for select areas); and Illinois vertebrate paleontological sites, including Illinois caves and public domain land sales.

The archaeological and paleontological site files are mandated by the Archaeological and Paleontological Resources Protection Act. The archaeological site file contains information, including site location data, for over 41,000 archaeological sites in Illinois. The vertebrate paleontological site file includes attribute and site location data for about 300 vertebrate paleontological sites and 200 archaeological sites with preserved faunal remains. These databases are accessed by other divisions within DNR and outside agencies for a wide variety of research and resource management projects.

The National Quaternary Mammals Database (FAUNMAP), provides distributions of mammals over the last 40,000 years based on findings at approximately 3,000 archaeological and paleontological sites in the United States. The database is distributed on disk with a publication — *Illinois State Museum Scientific Papers* XXV (1-2) — and can also be accessed via the Museum's World Wide Web site *(http://www.museum.state.il.us/research/faunmap/index.html).*

The Museum also serves as the host institution for the North American Pollen Database funded by the Geophysical Data Center of the National Oceanic and Atmospheric Administration. This database is also served on the WWW and can be accessed via the Museum's World Wide Web site *(http://www.museum.state.il.us/research/napd/index.html)* and a hyperlink to the Geophysical Data Center in Boulder, Colorado. It records original pollen data from hundreds of localities in North America and constitutes important proxy data for long-term changes in climate. Future plans call for a linking of the Pollen and FAUNMAP databases for a variety of mapping and other research applications aimed at studies of climate and vegetation change.

Large-scale databases have been developed for collections in art, anthropology, botany, geology, and zoology. These databases are being expanded to increase accessibility of information on the collections for professional and public uses and some are being linked to GIS databases. The Museum is also active in linking geographic and other data in the development of VRML (Virtual Reality Modeling Language) applications for research and exhibit uses.

Maps and GIS at the Illinois State Library

Arlyn Sherwood
Illinois State Library
Springfield, Illinois

Although the Illinois State Library (ISL) currently has no GIS, the Library's collection should not be ignored by those who are actively participating in GIS for at least two reasons: (1) the Library holds many resources potentially of use in building GIS databases, and (2) the Library is actively collecting GIS products and GIS literature.

The Library serves as Illinois's regional depository library, which means that it receives every publication of the federal government that the Government Printing Office (GPO) distributes, including paper maps and cartographic compact discs. Some significant types of federal mapping are not distributed through GPO, but the library has acquired the Illinois sets via other channels. Additionally, state law requires all state agencies to deposit copies of all their publications at ISL, including maps. These two programs constitute the overwhelming majority of the 160,000-sheet collection, but some important resources have been acquired through commercial channels as well. The following outline lists some of the most-used traditional federal, state, and commercial mapping that ISL holds:

Federal Mapping

- **U.S. Geological Survey (USGS)**
  - *Current*
    1. 1:24,000-scale topographic maps for the entire U.S.
    2. 1:100,000-scale topographic maps for the entire U.S.
    3. 1:250,000-scale topographic maps for the entire U.S.
    4. all other series published since 1984 for the entire U.S.
    5. Illinois NAPP photography for 1993 and 1988
  - *Historical*
    1. 1:24,000-scale topographic maps for Illinois and adjacent states
    2. 1:62,500-scale topographic maps for Illinois and adjacent states
- **FEMA**
  - flood insurance rate and flood hazard boundary maps for Illinois
- **U.S. Fish and Wildlife Service**
  - Illinois National Wetlands Inventory quadrangle maps
- **Census Bureau**
  - *Current*
    1. 1990 tract maps for the entire U.S.
    2. 1990 tract and block maps for Illinois
  - *Historical*
    1. tract and block maps from 1980 through 1940 for the entire U.S.
- **General Land Office (GLO)**
  - Original surveys of Illinois on microfilm

State Agency Mapping

- Illinois Dept. of Transportation (IDOT)
  - *Current*
    1. city street maps
    2. county highway maps
    3. state highway maps
  - *Historical*
    1. state highway map back to 1917
    2. county highway maps back to 1937
    3. city street maps back to 1940s
- **Illinois State Geological Survey (ISGS)**
  - coal-mined-out area maps
  - oil and gas development maps
  - geologic quads

- all published bulletins, circulars, etc.

Commercial Products

- late 19th century to current Illinois county atlases/plat books
- selected out-of-state historical county plat books/maps in microformat
- Sanborn fire insurance atlases for Illinois on microfilm

Digital Project on Compact Disc

- TIGER line files 1990, 1992, 1994, and 1995
- USGS Digital Orthophoto Quadrangles for the entire U.S.
- USGS Digital Raster Graphics (DRGs) for the entire U.S.
- USGS digital data series
- USGS Digital Line Graphs (DLGs) at 1:100,000 scale for the entire U.S.
- the IDNR Land Cover Atlas
- IDNR's Illinois Geographic Information System (May, 1996, two volumes)

As mentioned before, ISL is collecting GIS products and literature. Some of the maps in the collection plotted from the GIS at state agencies are listed below:

1. ISGS's open file series
2. ISGS's 1:24,000-scale coal mine maps
3. Illinois Department of Revenue's county taxing district maps
4. Illinois State Museum's archeological high probability area maps

Books and journals published about GIS are purchased as well. Journals subscribed to include *GIS World, GeoInfo Systems, ARC News,* and *Electronic Atlas Newsletter* among many others. There is also an unofficial file of newsletters from the various state GIS organizations, such as the *Nebraska GIS Update,* the *New Jersey GIS Update,* the *Montana GIS News,* and the *Arizona Geographic Information Council Newsletter.*

For those who do not otherwise have access to the cartographic data on the internet, ISL has terminals available to the public. The Library has full internet access via the Netscape Navigator 3.0 browser.

Finally, a word is appropriate about who can access the map collection and how it is available. ISL is the special library for state government, which means that state officials and employees doing work-related research may borrow items directly or receive free photocopies. All others are welcome to access the Library's collections and services in two ways: (1) by using their local library for borrowing or photocopying at no charge; or (2) by contacting the map staff directly, which would mean no borrowing privileges and a minimal photocopying fee.

The Library loans almost all federally produced mapping, paper and compact discs, with the exception of a few compact discs kept on the LAN jukebox. The Library also loans state agency mapping if more than one copy was acquired. Most county and city IDOT maps are single copies, as are most items plotted from the GIS. The Library loans the county atlases, the Sanborn microfilm, and the GLO microfilm. However, most items that cannot be loaned can be photocopied in black and white on the engineering copier. For those who would like to search ISL's catalogue, step-by-step connect instructions are available at *http://www.library.sos.state.il.us/io/io.html.* The Map Room (Room 305, 300 S. Second St., Springfield, Illinois 62701; 217.782.5823) is open to the public from 8:00 AM to 4:30 PM weekdays, except state holidays, but calling ahead is always wise.

University of Illinois at Urbana-Champaign Map and Geography Library

Jenny Johnson
Map and Geography Library, University of Illinois
Urbana, Illinois

The Map and Geography Library at the University of Illinois at Urbana-Champaign is one of the state's largest collections of cartographic and geographic information. Current holdings include over 550,000 maps and aerial photographs and 18,000 volumes. Subscriptions are maintained for 270 journal titles supporting research and instruction in geography, cartography, geographic information systems, remote sensing, and environmental science. The Map and Geography Library also has a small collection of digital geospatial data on CD-ROM; digital data will be receiving increased attention in the coming year.

Maps are received as depository items from federal and state government, as gifts, and by purchase. The collection aspires toward having comprehensive world coverage. Many of the maps can be borrowed from the library with appropriate identification. Some restrictions apply based on the age and physical condition of the materials.

Aerial photographs are retained only for the state of Illinois and include older photographs produced by the United States Department of Agriculture, as well as more recent aerial photography from the Illinois Department of Transportation. Part of the Map and Geography Library's home page (URL below) lists Illinois counties and years of available coverage. Local users consult indexes to determine which frames cover their site and then complete a request form, which employees of the Map and Geography Library use to pull the photographs. Users may be asked to return the next day as staffing constraints might not allow for immediate fulfillment of requests. Distant users are invited to fax a map showing their site of interest. Employees of the Map and Geography Library will do their best to pull the appropriate photographs. Aerial photographs may not be borrowed, but a procedure is in place for users to order reproductions though the university's Photographic Services Division.

Aerial photographs are the focus of a pilot project currently underway as a joint project of the Map and Geography Library, the university library's Digital Imaging Initiative, and the university's Geographic Modeling Systems Laboratory. The goals of this project are twofold: conservation of a badly deteriorated collection and provision of innovative electronic access to digital information. Based on benchmarks previously established by the Map and Geography Library, the Illinois State Geological Survey, and Scantech Color Systems, Inc., of Champaign, the pilot is working toward developing protocols and an interface to make scanned photography of Illinois flown between 1935 and 1955 available through the world wide web. Users will be able to view JPG images and download the JPG files and TIFF files produced by scanning the photographs at approximately 600 dpi. By the end of 1997 a test database of 270 photographs flown in 1939 and 1954 of central Will County will be available for access and evaluation purposes. The pilot project is being supported by the Illinois State Library and Scantech Color Systems, and its progress can be seen by accessing *http://images.grainger.wuc.edu/airphotos.htm.*

The Map and Geography Library is located at 418 Library, 1408 West Gregory Drive, Urbana, Illinois, 61801. The phone number is 217.333.0827, and the fax is 217.333.2214. Please clearly address fax transmissions to the attention of the Map and Geography Library. URL: *http://www.library.uiuc.edu/max/*

Chicago Area Geographic Information Study

Jim Bash
CAGIS — University of Illinois at Chicago
Chicago, Illinois 60607

The Chicago Area Geographic Information Study (CAGIS) is involved in several new GIS activities. This fall CAGIS and the Northeastern Illinois Planning Commission (NIPC) received an award from the Federal Geographic Data Committee (FGDC) for the development of a multiorganizational regional Geospatial Data Clearinghouse Node for northeastern Illinois. The National Spatial Data Initiative Clearinghouse is a system of software and institutions to facilitate the discovery, evaluation, and downloading of digital geospatial data. (For more information on the clearinghouse visit the FGDC's Web page at *http://www.fgdc.gov/clearinghouse/*).

The Northeastern Illinois Regional Clearinghouse Node will include metadata from several regional, county, and local agencies. It is will be available to other agencies in the region that wish to share geospatial metadata that is FGDC-compliant. The development of the node includes preparing and standardizing metadata compliant with the National Spatial Data Initiative as well as setting up a Z39.50 server for the query, search, and presentation of search results to Web clients. This server will be registered with the Clearinghouse Registry, enabling network-based users to pose queries and access metadata at any site. To query the collection of servers known as Clearinghouse, HTML and Java clients have been written under contract to the FGDC to provide consistent and supported access to the Clearinghouse Z39.50 gateway. The initial version of the Chicago Regional Clearinghouse project will consist primarily of geospatial metadata. However, if associated spatial datasets are publicly available without other restrictions, it is anticipated that they will also be directly available for downloading.

In another new activity, CAGIS and NIPC are developing a spatial data catalog for the Chicago Region Biodiversity Council. The council, the umbrella organization for the Chicago Wilderness initiative, is a coalition of local, state, and federal governments; research and education institutions; landowners; and conservation groups that have joined forces to help protect, restore, and manage the natural lands and the plants and animals of the Chicago region — stretching from southern Wisconsin through Illinois and around Lake Michigan into Indiana. (For more information on the Web about Chicago Wilderness go to *http://www.chiwild.org/*). The CAGIS/NIPC catalog project involves working with the members and the Chicago Wilderness GIS coordinator to inventory the spatial data of individual agencies and develop a systematic process to collect, maintain, and access spatial data relevant to Chicago Wilderness. The resulting digital inventory will be available through the Wilderness Web pages via links to CAGIS's Web server. It is hoped that this project will serve as a first step in the development of decentralized, regional spatial data that are timely, dynamic, accurate, and accessible to support the planning, research, analysis, project management, and other needs of the multiple organizations involved in biodiversity conservation through active restoration, conservation, and management efforts.

CAGIS has also added some features to its Web pages. Census Bureau TIGER Line files (TL95)

for Illinois are now available for download. A set of links is also available to other online sources for TIGER files (both original TIGER Line files and extract or reformatted files). These resources were added after the Census Bureau removed TIGER files from its Web site due to bandwidth problems, and the only other known online source for nationwide TIGER Line files also became unavailable. The TIGER files are available at *http://www.cagis.uic.edu/tiger/* or start from the CAGIS/Geography home page at *http://www.cagis.uic.edu.*

CAGIS continues to update addresses in TIGER Line files for the five Chicago collar counties (DuPage, Kane, Lake, McHenry, and Will) under contract with PACE Suburban Bus. Final preparation of files and metadata for the first update is occurring now, and CAGIS is in the second round of adding street segments and address ranges.

CAGIS is a research and service unit within the Geography Program and Anthropology Department of the University of Illinois at Chicago and a coordinating member of the Illinois State Data Center Cooperative. For more information contact:

Jim Bash
Associate Director
CAGIS (m/c 092)
University of Illinois at Chicago
1007 W. Harrison
Room 2102 BSB
Chicago, Illinois 60607-7138

312.996.5274
jbash@uic.edu
http://www.cagis.uic.edu

Updates — Local Government Agencies

Northeastern Illinois Planning Commission

Nina Savar
Northeastern Illinois Planning Commission
Chicago, Illinois

Since its first report in *Illinois GIS & Mapnotes* in September 1990, the Northeastern Illinois Planning Commission (NIPC) has implemented much of what it originally set out to do with its Regional Geographic Information System (ReGIS). Our objective then and now is to maintain a six-county, regional base of data and geodata from which we can perform regional analyses and support regional decision making. In addition, we have continued an informal educational outreach program for our constituents to encourage discussion on timely topics such as metadata and the Federal Geographic Data Committee and the use of digital orthophotography. Our outreach program also provides an introduction to GIS for planners and an introduction to cartography as well as a discussion of the update to the U.S. Census Bureau's TIGER/Line file. In the spirit of learning and sharing, NIPC continues to give free GIS demonstrations and to teach ArcView workshops and provide data at minimal cost to the user.

One of ReGIS's outstanding accomplishments in 1994 was the completion of the 1990 Land Use Inventory. This inventory was interpreted from 973 aerial photographs across the six counties of northeastern Illinois. Up to 49 categories were interpreted down to a resolution of 2.5 acres in suburban areas and .25 acres within the city of Chicago. Staff have just begun to update this inventory, beginning with Will and Lake Counties and the city of Chicago. We expect completion of this update in 1999.

One of this year's next projects will be to complete the digital map of the region — a compilation of our 1:24,000-scale base geodata. The map will include selected roads and transportation, hydrography, political geographies (minor civil divisions and municipalities), quarter sections, open space (county forest preserves and other major open spaces), and USGS digital raster graphics. It will also include some of NIPC's socioeconomic data by section such as 1990 and 1995 population and employment and projected population and employment for 2020 for municipalities and minor civil divisions.

Other recently completed and ongoing projects that rely heavily on GIS include the following: an

advanced identification of wetlands (ADID) for McHenry County; an inventory of nonmotorized facilities (bikeways); the Year 2000 Regional Greenways and Trails Implementation Program (1997 update to the regional greenways plan); the 2020 population and employment forecasts; and cumulative impact studies for the I-355 South corridor, the I-80 extension, and the proposed third airport. These projects include comprehensive plan integration not done before in these areas.

Currently, NIPC staff share a Federal Geographic Data Committee (FGDC) grant with the Chicago Area Geographic Information Study (CAGIS) to create an NSDI clearinghouse node for northern Illinois. This clearinghouse is intended to house compliant metadata for any public agency, academic institution, or private-sector entity wishing to participate. Concurrently, NIPC and CAGIS staff have a second grant to establish a catalog of select digital and nondigital geospatial data for the Chicago Wilderness Initiative, an organization of environmentally oriented groups focused in northeastern Illinois, southeastern Wisconsin, and northwestern Indiana. NIPC staff helped create and continues to support — along with the staff efforts of Cook County — the Northeastern Illinois ARC Technology Users' Group. The group meets about four times a year and features a wide variety of topics.

As NIPC moves its GIS into the future, we will be incorporating digital ortho images into our basemapping activities. As more local GIS efforts near completion, we will be spending more time integrating data from different sources, allowing more time for analyses. NIPC expects to link its monitoring program (data reflective of short-term land consumption) more directly with its GIS.

What began nearly eight years ago as a project-funded GIS originally implemented by technologists, has more recently permeated NIPC's organizational culture at all levels. As we move our emphasis from GIS establishment to GIS as a decision support tool, we will find our challenges in maintaining financial support, establishing new cooperative relationships, and providing wider and more sophisticated access to those who need it. For more information, contact:

Nina Savar
GIS Manager
Northwestern Illinois Planning Commission
222 South Riverside Drive
Suite 1800
Chicago, Illinois 60606

312.454.0400
nsavar@nipc.org
http://www.nipc.cog.il.us

Adams County GIS 2002 Status Report

Patrick Poepping
Poepping, Stone, Bach and Associates, Inc.
Quincy, Illinois

The Adams County GIS 2002 project can best be described as a complete countywide GIS. The project began with a 1992 needs analysis followed in 1995 by a one-square-mile pilot project. In 1995, the county received a National Spatial Data Infrastructure (NSDI) cooperative agreement grant from the Federal Geographic Data Committee (FGDC) to integrate NSDI cadastral standards into the pilot development. This work is complete and has been submitted to the committee.

In August of 1997, the Adams County GIS project received a grant from the NSDI Competitive Cooperative Agreement Program. This grant will be used to further develop the 1995 findings. This award provides for the further development of the NSDI cadastral standards data model by focusing on the following items:

1. User interface design for data entry and retrieval.
2. Standardizing complete database design.
3. Formation of parcel mapping construction rules and procedures.

We expect that completion of these three elements will result in a relatively user-friendly system that will enable personnel of Adams County and the city of Quincy to begin the task of building a countywide parcel base in accordance with the NSDI cadastral standards. The results are expected to have widespread application and will be provided nationally in an easily accessible form to people undertaking parcel mapping in their communities.

Other projects currently underway include a complete addressing point coverage of the entire county, including the city of Quincy. This work is approximately 70% complete. In addition, the county has entered into a contract with Natural Resources Conservation Service to develop countywide digital soils maps. These maps are expected to be delivered during the summer of 1998. The digital ortho quads (DOQ), which served as the mapping base for the soils study, were received in December of 1996. These one-meter resolution ortho images are used daily by the project participants. A third project focuses on the county's urban areas, for which we are developing six-inch resolution digital ortho images. This enhanced mapping is complete for the entire city

of Quincy, and the 1.5-mile area around Quincy is scheduled for completion in late 1997.

Although the Adams County GIS project is not expected to be fully operational until the year 2002, the data being produced are used every day by the project's participants. For example, a recent planning study of highway corridors in the city of Quincy contains base map data that was derived from the GIS. In addition, one of the participants, MediaOne (formerly Continental Cablevision) is in the process of designing its new cable system using the Adams County GIS database.

The Adams County GIS 2002 project was featured in the July 1997 issue of *Civil Engineering Magazine.* The Central Illinois chapter of the American Society of Civil Engineers nominated this project for the 1997 Outstanding Civil Engineering Achievement Award. The winner was the Denver International Airport; however the Adams County project was featured in the runner-up category of Outstanding Others. Our project was the only entry that did not involve construction, an achievement of which we are very proud.

There is still a lot of work to be accomplished to get the system up and fully operational by the target date of 2002. So far, the project is on schedule and is expected to be fully operational in 2002.

The project participants include: Adams County, city of Quincy, Central Illinois Public Service Company, Adams Electrical Cooperative, Adams Telephone Cooperative, MediaOne, and Ameritech. Their active involvement along with the efforts of our engineering team of Klingner & Associates PC and Poepping, Stone, Bach & Associates, Inc., both of Quincy, Illinois, are the reasons for the successes that this project has achieved. For more information contact:

Dick Klusmeyer
Project Manager
Adams County Highway Department
5200 Broadway
Quincy, Illinois 62301
217.223.0614

Chuck Bevelheimer
Director of Planning and Development
City of Quincy
709 Maine
Quincy, Illinois 62301
217.228.4540

Status of Cook County GIS Activity

Alan Hobscheid
Cook County
Chicago, Illinois

Forest Preserve District

The Forest Preserve District of Cook County recently gained approval for the purchase of professional services to produce digital orthophotography for the entire Cook County area. Aerial photography will begin in the fall of 1997, and a final product will be available in the late spring of 1998. Data will be made available (on CD-ROM) for a set fee to be determined at a later date.

The Forest Preserve Districts of Cook and DuPage Counties were recently awarded a $75,000 Chicago Wilderness grant for a multispectral vegetation mapping project. The pilot area of the joint project is the Sag Valley Division of the Cook County forest preserves and the Waterfall Glen area of the DuPage County forest preserves. The project will define methodology for using low-altitude, high-resolution, multispectral imagery to classify vegetation quantitatively and to qualitatively assess the health of vegetation in the northeastern Illinois region. For more information, contact Brian Locascio, GIS Manager, 708.771.1087 or brian@fpd.co.cook.il.us.

Elections Department of the Office of the County Clerk

The Elections Department has interpreted and automated the new boundaries of the Cook County Board of Review, formerly the Board of Tax Appeals, from data provided by the state of Illinois.

The clerk's office has been working closely with the Illinois Department of Revenue to assist in the quality review of coverages representing various tax districts in the county. The clerk's office continues its ongoing duties to geocode individual registered voters to a street midline database in preparation for upcoming elections. ArcView 3 and Precis, a product of Election Data Systems, Inc., are the software packages being used to support this activity.

Emergency Telephone System Board

The Emergency Telephone System Board coordinates E911 activities for unincorporated Cook County and several other participating municipalities in conjunction with local fire and police districts. Cook County will soon have a complete 911 database consisting of street midlines and the various district boundaries to support a computer-assisted dispatch (CAD) system. A database manager has been hired to maintain the currency of the master street address guide (MSAG), which integrates with the database.

The Board will kick off the CAD project in October 1998. In addition, a wide-area network has been planned to service all participating agencies across the county.

Countywide Geographic Information System Database Project

Cook County is in the initial phase of a multiyear project that will eventually establish the county GIS database. All agencies concerned with land information have been major contributors to the planning process. These include the county board; the Offices of the Assessor, Clerk, Recorder, and Treasurer; the Forest Preserve District; the ETSB; and the Departments of MIS, Office Automation, Highway, Planning and Development, Sheriff, Revenue, Building and Zoning, Zoning Board of Appeals, Environmental Control, and Real Estate Management.

Aerial photography has been discussed for the spring of 1998. This photography will be the basis for all subsequent data creation and conversion services proposed below.

The database may initially include the geographic themes listed below. These will be developed from planimetric and photogrammetric sources, the tax maps currently maintained by the County Clerk, and other data sources.

1. Cadastral landscape, right-of-ways, and associated cartographic elements
2. Topography (contour mapping)
3. Hydrography
4. Ownership fence lines
5. Railroads
6. Road edges and sidewalks
7. Road midlines with address ranges
8. Building outlines for unincorporated areas
9. Public land survey system (PLSS)
10. Cultural features
11. Planimetric features associated with the county highway system, including bridges, culverts, curbs, driveways and other access, trees, traffic control, striping, poles, etc.
12. Planimetric features associated with the infrastructure of the Forest Preserve District
13. Regional coverages representing all taxing districts and PLSS polygons

A data warehouse solution is being developed to manage the linkages between the graphics and existing and proposed attribute databases. Hardware and software configurations are being considered and designed to maximally support public access as well as to optimize internal workflow.

The Harris Corporation has been selected as a consultant to assist in all phases of this project including assessing data and workflow requirements, re-engineering alternatives, and RFP development, review and selection, implementation, and quality control.

Lake County GIS Activities

Richard Hilton
Lake County Data Management Services
Waukegan, Illinois

Lake County government agencies and their branch operations are distributed over many different sites, including larger, campus settings as well as isolated locations. This has always posed a challenge for delivering GIS applications. Now, however, the county has committed to building a high-speed, wide-area network with the bandwidth necessary to support distributed access, particularly for the growing volume of image data associated with our GIS program.

Other technology changes underway include a phased replacement of UNIX servers and workstations with Intel-based hardware running Windows NT. We now routinely distribute data on compact disk, which seems to have solved the many problems previously encountered with partners using a variety of media and platforms. We've also recently acquired a Trimble Pathfinder GPS system and plan to use it for a variety of environmental data gathering projects in cooperation with other county agencies.

The ability to make GIS data available to county users by means of an intranet and to the public via the internet has provided a major new method for access. A number of users fall into the "casual user" category in that their needs are primarily to look at data rather than to do any formal analysis or other traditional GIS processes; we believe that most of these needs can be satisfied by using the web browsers these users already understand rather than having them purchase and train themselves in specialized GIS software.

The county program has always been based on partnerships wherever they were possible in order to create or exchange data. In addition to more than 20 municipal partners, some recent projects have included:

- Providing support to the Corps of Engineers Planning Office in their study of Des Plaines River flooding;
- Working with the Northeastern Illinois Planning Commission to update the Lake County portion of their regional land use map;
- Planning for an update of the soil survey with the Natural Resources Conservation Service.

Another product that is proving to be very useful is the availability of the images of our published parcel and tax district maps. These images display rapidly and include all of the cartographic detail of the published paper maps, a format that works well for many purposes. The 5,500 map images fit on a single compact disk. The images have been hot linked to a vector-based Arc/Info coverage, so that, for example, clicking on an area of interest on an aerial photograph pops up the official parcel map sheet for that area, using ArcView.

The GIS staff in the Management Services department is receiving a growing number of requests for customized maps and statistical analyses from county users and partners. It is expected that many users will be able to produce their own maps as the wide area network and other changes described above come into place over the next year. Several county agencies actively maintain their own overlays over the common base now; these agencies include Public Works, Planning, Health, Stormwater, and the Forest Preserve District. These agencies continue to make progress in their individual areas.

McDonough County Begins Exploring the Establisment of a GIS

Lawrence T. Lewis
Department of Geography, Western Illinois University
Macomb, Illinois

The Beginnings

In October 1996, David King, executive director of Prairie Hills Resource Conservation and Development Inc., organized a small committee of mostly nonelected persons whose task was to formulate a plan to investigate the feasibility of establishing a GIS in the county. One of the committee's first decisions was to educate potential users about the benefits of GIS. To do that it sponsored a half-day, informational seminar in January 1997.

Early in the spring of 1997 the committee decided to conduct a formal GIS needs assessment. The remainder of the spring was taken up with soliciting funds from city and county governments, utility companies, and private agencies to pay for that assessment.

The GIS needs assessment contract was awarded to Western Illinois University on July 7, 1997. The contract called for a graduate student and myself to conduct the assessment. In total we collected data from 24 agencies.

Some Preliminary Findings

As of this moment, we have assembled most of the data we sought. Although it is premature for us to state what recommendations will come out of our study, a few findings can be shared based on the response of members of four groups: city departments, county departments, utilities, and service organizations.

Seven county departments participated in this study. Four are located in the county courthouse and are networked to a common server. The Supervisor of Assessments is the only office that actually has a GIS, but it is used more like a CAD system than a GIS. The E911 office, which is housed in the City-County Building with the county sheriff and the Macomb police, has a rudimentary GIS that is greatly underutilized. The offices in this building are networked and have the most up-to-date assemblage of computer hardware of any of the public entities in the county.

We assembled data from seven departments of the city of Macomb. These offices are not centrally housed. With the exception of the Police Department (mentioned above) they are not networked, nor are they well-endowed with either hardware or software. Getting GIS into city operations will be difficult. As it stands now, the city may be content to continue to maintain its records either manually or in spreadsheets, and to continue contracting its mapping to a local engineering firm.

The county has five major utilities: two telephone companies;

two gas and electric power companies, and a cable TV company. The largest of the power companies is Central Illinois Power Service (CIPS). Recently it established a regional office in Macomb that covers a number of counties in western Illinois. Probably because of the regional nature of this office, it is well endowed with networked hardware and software. The regional office is largely using CAD programs for its facility management and only recently has added ArcView for some of its mapping. McDonough Power Co-op is the other power company. It is much smaller. Except for billing, it has few computer resources and no CAD or GIS capability.

The phone and cable companies either did not respond to our requests for information or expressed minimal interest in the project. A major factor in this disinterest is the deregulation of these industries, which has made competition fierce. Even the power companies, which indicated a strong probability that they would share data, may have second thoughts about data sharing when their industry is deregulated as early as 1998. This situation could pose a serious obstacle to subsequent steps to establish a GIS.

Lastly, we gathered information from six service agencies. Only the Western Illinois Regional Council (a quasi-planning agency) has adequate hardware and software for GIS. Currently the council operates two desktop GIS programs, mostly for creating simple thematic maps. The other service agencies are very small, and most lack adequate computer hardware and software. Most importantly, all these agencies would need more staffing and training if they were to take full advantage of a GIS.

We found two issues that need to be addressed before proceeding with a GIS: (1) the lack of sharing of data among existing entities; and (2) the lack of spatial data in either hard copy or digital form. Networking would address the first problem, and a properly georeferenced base is crucial to the solution of the second problem.

At the Turning Point

Until now the major driving force for the establishment of a countywide GIS has been individuals who are not elected officials. The county and the city of Macomb are now at a turning point. If a decision is made to go forward with a GIS, it must be led by elected officials who can influence expenditures.

Updates — Nongovernmental Organizations

Chicago Wilderness

Brett R. Ward
Chicago Academy of Sciences
Chicago, Illinois

Chicago Wilderness is the globally significant concentration of rare Midwest natural communities — the grasslands, woodlands, streams, and wetlands — that survive in the Chicago metropolitan region. It encompasses more than 200,000 acres of protected natural lands, including tall grass prairies and some of the finest open oak woodlands in the Midwest. In a first-of-its-kind collaborative effort in a metropolitan area, 34 conservation-conscious organizations have joined forces to help protect, restore, and manage these natural lands and the plants and animals that inhabit them. The member organizations are working to make the world-class nature in Chicago Wilderness an integral part of the everyday lives of the people of the region.

GIS is playing a significant role in Chicago Wilderness in a number of ways. The GIS work, projects, and meetings being done for Chicago Wilderness involve technology, people, and data from Chicago Wilderness organizations. These organizations are using GIS for the restoration, protection, and management of the natural resources in the Chicago Wilderness area. The GIS efforts will ultimately be incorporated in the Chicago Wilderness Recovery Plan.

A second project involves the preparation of a catalog, *A Spatial Data Catalog for the Chicago Region Biodiversity Council.* The principal investigators for the project are the Northeastern Illinois Planning Commission (contact person, Nina Savar) and the Chicago Area Geographic Information Study (contact person, Jim Bash). This project is developing a systematic process to provide for the collection, maintenance, and access to information about spatial data relevant to the needs of Chicago Wilderness and the Chicago Region Biodiversity Council.

Another project involves multispectral vegetation mapping in Cook and DuPage County forest preserves. The principal investigatory is the Forest Preserve District of DuPage County (contact person, Leslie Berns). This project is developing a quantitative means for determining the type and health of plant communities in Cook and DuPage County forest preserves using remotely sensed imagery.

A final project funded by Chicago Wilderness and feeding into the recovery plan is called *GIS Projects and Analyses for the Chicago Wilderness Recovery Plan.* The principal investigators include the Chicago Zoological Society (contact person, Jim Sullivan), the

Northeastern Illinois Planning Commission (contact person, Nina Savar), and Chicago Wilderness (contact person, Brett Ward). This project will use GIS to assess and analyze the state of biodiversity in the Chicago Wilderness area.

Another project that will benefit Chicago Wilderness but that we do not fund is titled *Tracking Natural Community Fragmentation and Changes in Land Use and Land Cover: A Case Study of Chicago Wilderness.* Principal investigators and collaborators on this project come from the following agencies: Field Museum of Natural History (contact person, Debra Moskovits), University of Illinois at Chicago (contact person, Yeqiao Wang), the Nature Conservancy (contact person, Stephen Packard), Chicago Zoological Society (contact person, Tim Sullivan), Chicago Wilderness (contact person, Brett Ward), and the National Aeronautics and Space Administration. This project will produce a regional map of current vegetation and analyze trends in habitat conversion and fragmentation over the last 25 years.

Another way in which GIS plays an important role in Chicago Wilderness is through a GIS task force. The task force meets on a monthly basis to discuss issues pertinent to Chicago Wilderness and GIS. These issues include the Chicago Wilderness recovery plan, team priorities, project status, project ideas, workshops, and conferences. GIS users as well as other interested parties from many of the Chicago Wilderness organizations attend the monthly task force meetings.

Nina Savar, James Bash, and Brett Ward also organized a seminar called *The ABCs of GIS,* which was held on September 30, 1997. At the seminar Chicago Wilderness members were introduced to the concepts of GIS. Speakers included William Holland of GeoAnalytics, Nina Savar, and Brett Ward.

Chicago Wilderness has a Web site where more information about the organization and its activities can be found. The address is *http://www.chiwild.org.* Chicago Wilderness GIS has its own pages within the Chicago Wilderness site. The address is *http://www.chiwild.org/gis.*

Metro Chicago Information Center

Jason Pestine
MCIC — Metro Chicago Information Center
Chicago, Illinois

The Metro Chicago Information Center (MCIC) is a nonprofit research and consulting firm founded in 1989 by area foundations and the United Way of Chicago. MCIC's mission is to provide top quality, state-of-the-art research services, geographic analysis, and data to other nonprofit organizations, foundations, government agencies, educational institutions, and the private sector in northeast Illinois.

MCIC is a membership organization that specializes in research primarily concerned with the quality of life in the metropolitan Chicago area. MCIC has approximately 225 member organizations, including: 100 nonprofit organizations from the social services, cultural, and other sectors; 75 organizations from the health care sector; 23 organizations from the banking and other corporate sectors; and 23 government and educational institutions.

In addition to serving and educating its members, MCIC has a long-standing practice of furthering the education of students. MCIC routinely utilizes the services of student interns to complete a wide range of GIS services and projects. Recent interns have joined us from DePaul University, University of Illinois at Chicago, University of Kansas, and Northeastern Illinois University.

As part of its mission, MCIC conducts an annual quality-of-life survey of over 3,000 households in the Chicago metropolitan area of Cook, DuPage, Kane, Lake, McHenry, and Will Counties. MCIC provides certain research services at little or no charge to foundations and nonprofit member organizations. To subsidize these charitable and educational activities, MCIC takes part in service agreements and special projects, where member organizations make use of MCIC's advanced research and consulting services. MCIC provides GIS and other research services to the following sectors.

Health Care Research Services

MCIC currently assists over 60 members in health needs assessment, strategic and program planning, marketing and advocacy. Our services address key planning issues such as health care needs, market profiles including demographics, health facilities and health status, and health services and site selection analysis for new health care initiatives. A few of our larger members include Advocate Health Care, Catholic Health Partners, Chicago Department of Public Health, Cook County Bureau of Health Services, Loyola University Health System, and Rush System for Health.

Financial Institutions Research Services

MCIC currently assists over 20 members to comply with the Community Reinvestment Act as well as with lending analysis, strategic market planning, site analysis, and community financial needs assessment in targeted areas. MCIC was named the local affiliate in Chicago for the Business and Industry Data Center program of the Department of Commerce and Community Affairs, which includes datasets such as Dun & Bradstreet, American Business Information, Regional Economic Models, Inc., and Illinois Department of Employment Security. Members include ABN AMRO North America, Inc., Bank of America, First Chicago Bank, Federal Reserve Bank of Chicago, Northern Trust Bank, TCF, and the U.S. Department of the Treasury.

Arts and Culture Research Services

MCIC has extensive experience in providing market research for Chicago-area museums, cultural groups, and providers of entertain-

ment and leisure activities.

MCIC's clients include almost all of the major cultural institutions in the Chicago area — Art Institute of Chicago, Museum of Contemporary Art, and the Field Museum of Natural History — as well as many organizations offering leisure activities and events. This last group includes the Chicago Convention and Tourism Bureau, Chicago Architecture Foundation, Museum of Science and Industry, Business Owners and Managers Association of Chicago, and the Chicago Botanic Garden.

Housing and Economic Development Services

MCIC currently works with approximately 30 housing and economic development agencies throughout the Chicago area, providing housing and economic data, custom research services, mapping, and data analysis. Members use MCIC's services for neighborhood economic development plans, economic and demographic forecasts, new business attraction programs, neighborhood housing development plans, and community financial needs assessment. Members include Metropolitan Planning Council, Chicago Department of Planning and Development, Chicago Association of Neighborhood Development Organizations, Northwest Housing Partnership, and Chicago Housing Authority.

Ongoing Major GIS Research and Projects

SOLAR — Strategic Open Lands at Risk

The SOLAR mapping project is a joint venture between MCIC and Openlands Project. The purpose of SOLAR is to identify and map development trends across the vast Chicago region and call attention to how those trends may place valuable resource-laden lands at risk. The study area includes nine Illinois counties and three counties each in Indiana and Wisconsin. SOLAR will culminate in a series of maps and reports that will indicate where development pressures are strongest in the immediate future and where they are likely to emerge in the next decades. SOLAR will also identify strategic resources — lands that should be protected and areas that can absorb the predicted growth over the next 25 years.

Information will be gathered from numerous sources including one-on-one interviews and focus group sessions, allowing planners, open space providers, environmentalists, and public interest groups to share information about their area. Data collected from these meetings and informational sessions will be compiled on hard copy maps and in digital form. Hard copy maps will be digitized and merged with additional information provided by the counties and different planning organizations. Analysis will be performed on the number of acres at risk on a macro scale, and in some instances, by city. The project will be replicable for future "report cards" to track open space acquisition and sensible development. The maps and reports will be used to facilitate discussion and policy among the area planning agencies and advocacy groups.

Historical Mapping

MCIC is currently constructing historical census maps that date back to the early 1900s. Census tract boundaries are being reconstructed from hard copy maps for each decennial year. MCIC has already created a number of maps for the six-county Chicago metropolitan area. Various demographics are being mapped to show trends in population for reports and presentations. The historical project is being expanded to represent 16 of the counties surrounding Chicago.

Recently Completed GIS Research and Projects

Bank Enterprise Award Program

MCIC just finished an extremely successful project with the US Department of the Treasury, serving as the national help desk for the Bank Enterprise Award program. The program, sponsored by the Community Development Financial Institutions Fund, is designed to provide incentives to banks and thrifts to invest in Community Development Financial Institutions and/or increase their provision of lending and services within distressed communities. Banks and thrifts that applied for grant awards through the program needed to gather many items of data. MCIC provided the most important component, the Distressed Community Designation, which is used to determine the amount of the award based on past lending activities and projected activities.

Distressed Community Designation can be determined at six different census-defined geographic levels: county, incorporated place, minor civil division, census tract, block numbering area, or American Indian or Alaska Native area. All geographic units must meet three stringent requirements for eligibility as a distressed designation. First, the poverty rate from the 1990 US Bureau of the Census must meet or exceed 30%. Second, the unemployment rate must meet or exceed 1.5 times the national unemployment rate, based on 1996 estimates of the Bureau of Labor Statistics. Three, population must be greater than 4,000. These three factors were used to calculate a final ratio to determine the geographies' eligibility. If a single geography did not meet one of the requirements, contiguous geographies could be aggregated. A group of geographies was selected to calculate the final ratio for qualification.

MCIC's GIS staff processed requests for over 90 separate banks and institutions. Although many of these lending institutions required one to two areas, the largest request from a single bank was 23 of the largest cities in the United States such as Chicago, New York, Los Angeles, Dallas, Philadelphia, and Boston. For each of the distressed areas, MCIC provided a map of the area and a completed worksheet for the application. Using Arc/View and Avenue the staff selected distressed areas, queried the database of over 70,000 records, recalculated the variables, and told the institutions their qualified area in a matter of seconds in most cases. Distressed areas ranged from as few as one to three census tracts to 300 census tracts for one area. In only three weeks, MCIC produced over 170 maps of distressed areas which included over 280 distressed community designations and worksheets.

An Atlas of American Real Estate Appraisers

MCIC recently worked with the Appraisal Institute to produce *An Atlas of American Real Estate Appraisers,* the first and only systematic study of real estate appraisers practicing in the United States. This publication provides an accurate snapshot of the American appraiser population, which will help appraisal firms identify their professional colleagues and competition in the real estate marketplace.

The atlas includes an abundance of both specific and general information. Extensive tables present data on all types of registered appraisers broken down by type of registration and location. The current distributions of appraisers are mapped by census district, state, metropolitan statistical area (MSA), and county, and the results are extrapolated to the year 2000. Current and projected population estimates are analyzed to

identify where appraisers are needed now and where shortages will occur in the future. The representation of Appraisal Institute members among all appraisers is also explored.

MCIC built the appraiser database from two primary sources: The National Technical Information Service dataset, which contained 81,963 entries, and the Appraisal Institute membership database, which included 23,373 entries. A rigorous cleaning process was applied to the databases to eliminate duplications and generate a combined data set containing 76,532 entries. A final review of our process of eliminating duplications using a random sample telephone survey revealed an error rate of 0.13%. The cleaned database was than geocoded to the county level to produce over 100 maps and tables for use in the atlas, which is being used as an educational guide to better understand today's market and future strategies for the appraisal industry.

A Decade of Transportation Spending

In a recently published report to the John D. and Catherine T. MacArthur Foundation entitled *Mapping the Future* by Myron Orfield, MCIC provided data and mapping of the transportation spending patterns for the Chicago metropolitan region from 1984-1994. Raw data for this project were obtained from the Illinois Department of Transportation and the Illinois State Toll Highway Authority. Over the ten years of the study the two agencies completed nearly 6,000 projects, most of which required manual geocoding. The project numbers were used as a common ID number for the work to enable MCIC to ensure the data's accuracy and allow easy verification.

From the ten years of data, two main sets of numbers were developed, total highway and tollway improvement spending and new capacity highway and tollway spending. New capacity is defined as projects that add additional capacity to the roadway such as additional lanes, new ramps, and new bridges. During the period of the study, the two agencies spent close to $5 billion on the road system in the Chicago metropolitan area. Analysis of the data was compiled at three different levels of spending: countywide, DRAM/ EMPAL zones, and by individual projects. The maps provided the ability to visualize a decade of changing transportation and growth.

Metro Chicago Political Atlas

MCIC has just completed the *Metro Chicago Political Atlas '97–'98,* now in its third edition. The atlas is a joint venture between MCIC, the Chicago Urban League, Northern Illinois University, and the Institute for Public Affairs. The atlas examines the racial composition of the area and analyzes the way in which race-based constituencies differentiate themselves in the voting booth. The atlas contains 65 geopolitical maps analyzing 23 recent elections. Several different levels of geography are used for the mapping in the atlas. These include city of Chicago precincts, Cook County townships, zip codes, Illinois House districts, Illinois Senate districts, and census tracts. The atlas is used as a teaching instrument for political scientists, sociologists, and journalists throughout the country, highlighting differences between Chicago-area politics and the rest of the state. The atlas represents the only generally available publication of its kind analyzing such a complex issue as Chicago area politics.

Metropolitan Futures Project

MCIC provided geographic analysis and mapping for the Metropolitan Futures Project, a study

organized by community leaders from the Commercial Club of Chicago. MCIC served as technical support for the task force on education, acquiring datasets and preparing maps for all aspects of the education industry in the region including: location of facilities (public, private, all grade levels including community colleges and adult vocational education); demographics of enrollees; and test scores as outcome measures of the education process. Patterns evident in the maps and tables facilitated discussion and policy review. Advocacy groups are using the maps and data to further strengthen areas that are well below the national average in test scores and school funding.

Archdiocese of Chicago

MCIC provided mapping and geocoding to the Archdiocese of Chicago, producing over 100 maps for inclusion in a comprehensive planning project. Maps depicted current year estimates for 1996 and projected numbers for 2001 on a wide range of variables such as total population, school age population, race, and income (Figure 1). The mapping was used to show projected population trends with respect to the location of churches and schools.

Section 8 Voucher Recipients

MCIC has assisted the Chicago Housing Authority in ongoing geocoding and mapping of all its Section 8 Voucher recipients (Figure 2). MCIC analyzed where recipients live in relation to demographic characteristics such as the percentage of renter-occupied housing, age, total population, and percentage in poverty. Part of the housing authority's relocation plan includes moving residents into areas with less than 20% of the population in poverty. MCIC provided maps and tables of census tracts where the recipients are allowed to move.

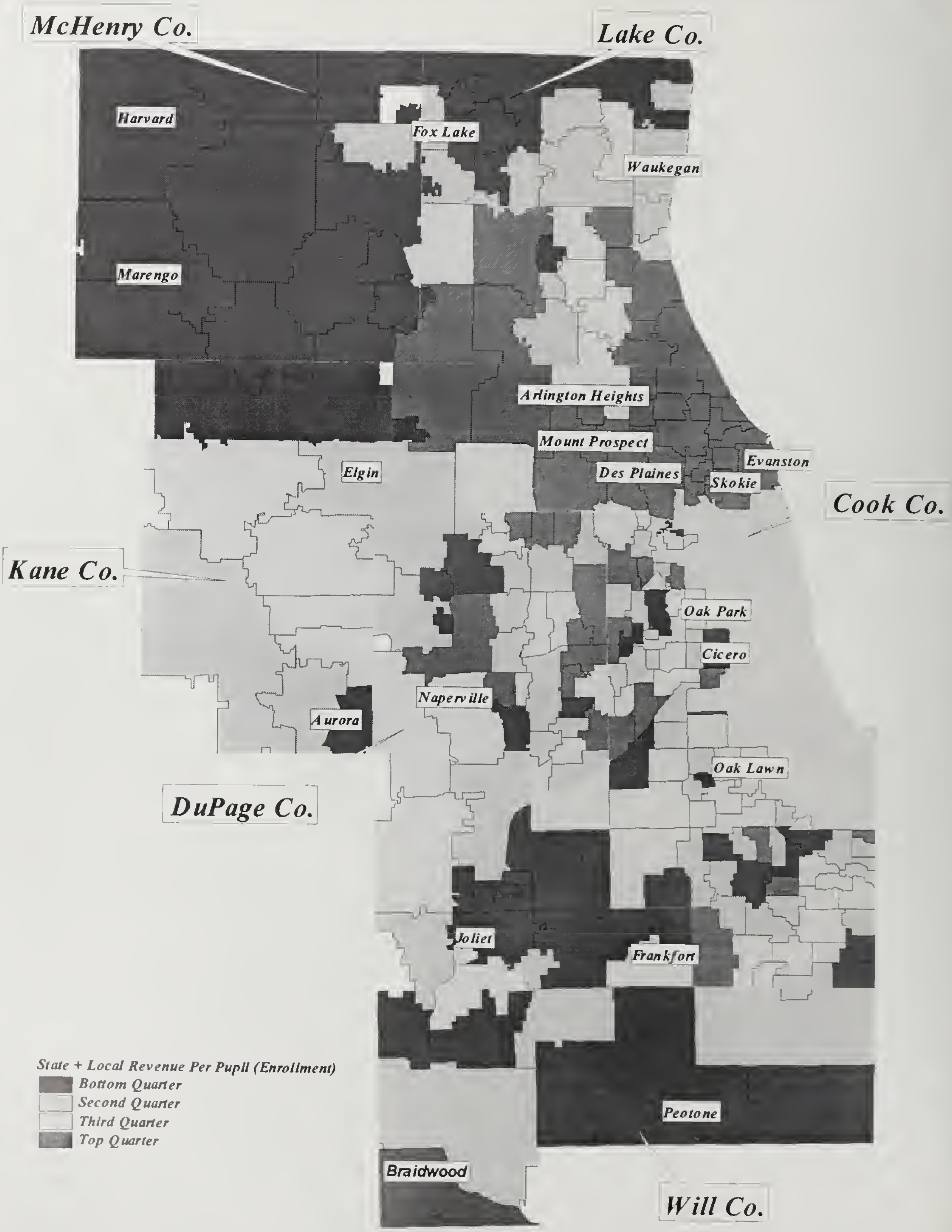
Museums in the Park Tourism Survey

MCIC conducted research on behalf of the Museums in the Park, including Adler Planetarium, Art Institute of Chicago, Chicago Academy of Sciences, Chicago Historical Society, Field Museum of Natural History, Museum of Science and Industry, and Shedd Aquarium. Intercept interviews of visitors from outside the Chicago region were conducted at these as well as at Navy Pier, Woodfield Mall, and Wrigley Field. Survey questions addressed how and when respondents decided to attend each location as well as other tourist destinations, and memberships. Membership data were used to map penetration rates for zip codes in the Chicago metropolitan area, as well as the rates of visits from other states.

The preceding projects are in progress or have been completed or over the last year and a half. MCIC is always expanding the capabilities of its GIS department to meet the needs and demands of our membership. If you have questions on any of the projects or research at MCIC please contact Jason Pestine, GIS Specialist, at 312.580.2972 or jpestine@mcic.org

Figure 1
Archdiocese of Chicago, Vicariate V, number of households receiving less than $15,000 income in 1996

Figure 2
State and local revenue per pupil unit and elementary school districts, 1994–95



Cumulative Index

Illinois GIS & Mapnotes, 1981–1996

This cumulative index to *Illinois GIS & Mapnotes* covers 18 issues published during the 16 year period 1981-1996. From 1981 to 1988 ten issues were published under the title *Illinois Mapnotes.* In 1989 the title was changed to *Illinois GIS & Mapnotes*. The numbering and dates of the issues are listed below:

Illinois Mapnotes

Volume	Date
1	June 1981
2	December 1981
3	June 1982
4	Spring 1983
5	Spring 1984
6	Spring 1985
7	Winter 1985
8	Spring 1986
9	Winter 1987
10/11	1988

Illinois GIS & Mapnotes

Volume	Date
9(1 and 2)	September 1989
10(1)	September 1990
10(2)	May 1991
11(1)	Spring 1992
11(2)	Summer 1993
12(1)	Fall 1994
13	Fall 1995
14	Fall 1996

In Memory
Richard E. Dahlberg
1928 - 1996

This display of maps and graphics, in a small way, is intended to honor the memory of Richard E. Dahlberg, a man I was privileged to work for and with for over 27 years. He was a boss, a colleague, a friend, and most importantly, the never ending source of knowledge at the end of the hall. The portions of USGS 7.5 Minute Quadrangle maps, at right, come from a collection of maps he had acquired over a lifetime of teaching at several universities. He would quite often use them to show students how landforms affected man's settlement patterns and the interesting arrangement of contours generated by them. In the process of helping to clean out the many drawers worth of materials he had saved over the years, I stopped to study some of the maps more closely and began to let my imagination run a bit wild. In the WILLIAMSON, NY quad, I could imagine an artist throwing balloons filled with paint against a vertical canvas, one balloon after another hitting in nearly the same spot and sagging towards the floor, creating a pop art masterpiece entitled "Splat". In the COW SPRINGS MOUNTAIN, N. MEX. quad, I immediately saw two eggs cooking "Sunny Side Up" in a frying pan. The upland contour lines on the MOREHEAD, KY quad seemed to form shapes characteristic of the lobes in the brain. In an effort to "float" that portion of the image above the background, I used the yellows and oranges in the lowland areas. It was at that time that the name "Brainstorm" came to mind (no pun intended), as the yellows and oranges gave a look of electrical activity. Many other quads also revealed very interesting patterns but in the end I decided to use the previously mentioned quads for this poster. It was only after I had placed the three digital images on the Macromedia FreeHand document that I looked at the names I had chosen and realized how much they said about Dick as a person. The splash of color on the WILLIAMSON, NY quad represents his love of color. He had more books and more knowledge of color theory and color design than anybody I know. I believe it was the thing he enjoyed most when it came to contributing to the production of a map in the Cartography Lab at NIU. "Sunny Side Up" describes his almost always upbeat attitude. He would usually greet you with a smile and a bit of humor, sometimes even after a visit to the dentist after root canal work. "Brainstorm" probably says the most about him, however. His drive for knowledge, organization, and to teach others was amazing. At times it even made the rest of us tired to watch him work such long hours and become involved in so many activities, but that's what he truly enjoyed and I don't think he would have had it any other way.

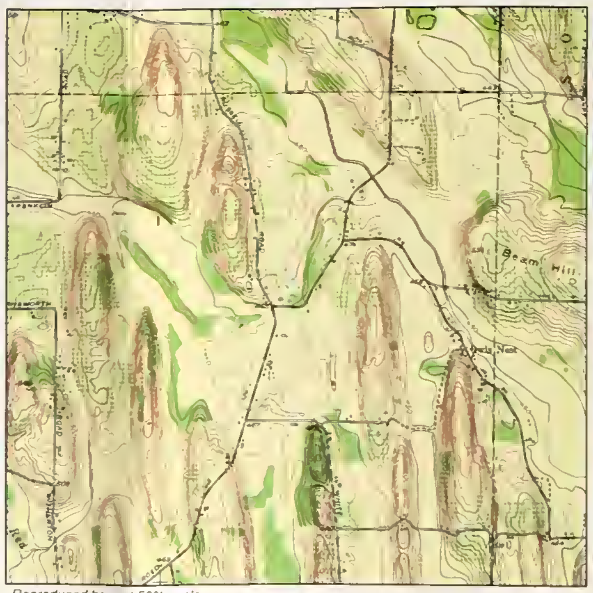
I'm still working on cleaning out his old office. Each time I approach the office door, if the morning sunlight coming through the window is just right it silhouettes his sweater that still hangs behind the door. The first time I noticed it, I got the feeling that maybe if I knocked he'd say "yah, come on in" . . . maybe I'll leave that sweater hanging there after the cleanup is done.

Richard P. Vaupel

A scholarship has been established in Dr. Dahlberg's name for graduate students pursuing cartography related fields in the Geography Department at Northern Illinois University. If you would like to be a part of his dream to educate others, please send your contribution to the address below. Make checks payable to the **NIU Foundation** and specify that your contribution is restricted to the ***Dahlberg Scholarship***.

Northern Illinois University Foundation
Advancement Services
Swen Parson 220
DeKalb, IL 60115-2882

Many thanks to Pat Dahlberg, Jay Stravers, Professional Graphics of Rockford, IL, and Johnson Press of Rockford, IL for their generous contributions in the production of this memorial.



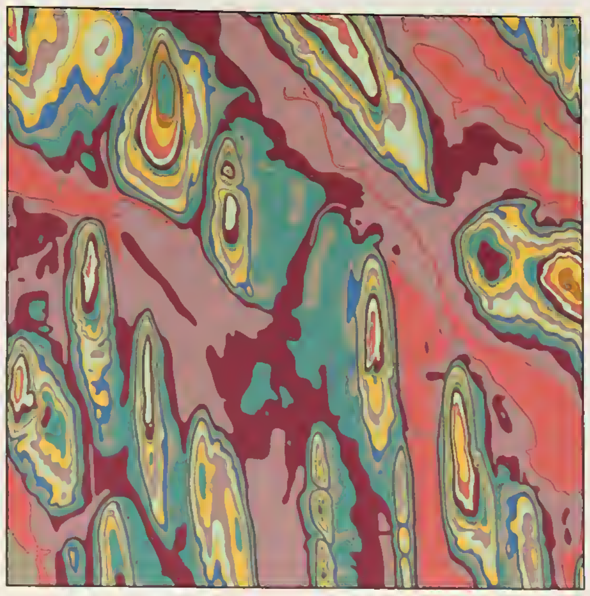
Reproduced here at 50% scale

QUADRANGLE LOCATION

Portion of
WILLIAMSON, NY
USGS 7.5 Minute Quadrangle
1952

0 1 Mile

Contour Interval 10 Feet



– *Splat* –

The contour patterns represented here are the result of glacial activity across New York State approximately 18,000 thousand years ago. The elongate hills (drumlins) were formed as unconsolidated sediment beneath the Laurentide Ice Sheet was deposited and sculpted or molded into these streamlined forms by active ice flow from north to south.

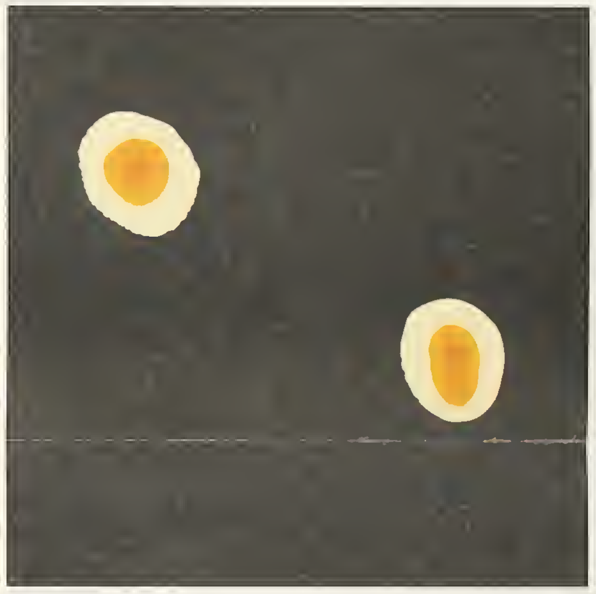
Reproduced here at 50% scale

QUADRANGLE LOCATION

Portion of
COW SPRINGS MOUNTAIN, N. MEX.
USGS 7.5 Minute Quadrangle
1939

0 1 Mile

Contour Interval 20 Feet



– *Sunny Side Up* –

The contour lines that form the eggs in this image owe their existence to differential weathering and erosion of solidified lavas from ancient volcanic activity in these arid lands. Over the millennia most of the volcanic rock has been eroded away, exposing softer underlying sediments, leaving behind gently sloping alluvial deposits surrounding isolated towers of resistant volcanic rock.

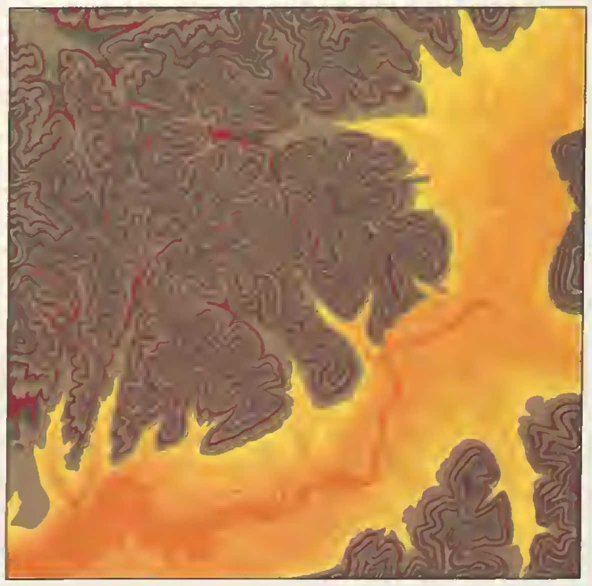
Reproduced here at 50% scale

QUADRANGLE LOCATION

Portion of
MOREHEAD, KY
USGS 7.5 Minute Quadrangle
1953

0 1 Mile

Contour Interval 20 Feet



– *Brainstorm* –

The contour patterns represented here are the result of millions of years of fluvial erosion across flat lying limestone which has produced an intricate dendritic pattern of branching streams and tributaries (the colorful "gray matter" and "arterial pathways" of the brain). The "brain stem" running diagonally from southwest to northeast is a large deep valley, cut from bedrock, and almost completely filled with recent fluvial sediments to form a broad flood plain.

ey to Map of Major Map ibraries

. Illinois Department of ansportation, Central Office, erial Survey Section, Room 005, 00 S. Dirksen Parkway, ringfield, IL 62764. 7 782 7627.

. Chicago Aerial Photo Services APS), collection of historical d current aerial photography 949-1997, 2140 Wolf Road, Des aines, IL 60018. 847 298 2277 x 847 298 2 69. Contact Syed kander.

Southern Illinois University at rbondale, Morris Library, ience Division, Map Library, arbondale, IL 62901. 8 453 2705.

Illinois State Geological Survey, brary, Map Room, Natural esources Bldg., 615 E. Peabody rive, Champaign, IL 61820. 7 333 5110.

Eastern Illinois University, ooth Library, Reference epartment, Map Collection, harleston, IL 61920. 7 581 6072.

Chicago Historical Society, brary Map Collection, Clark reet at North Avenue, Chicago, 60614. 312 642 4600.

Chicago Public Library, overnment Publications epartment, 400 S. State St., hicago, IL 60605. 312 747 4500.

Illinois Institute of Technology, brary, Documents Department, 00 S. Federal Street, Chicago, IL 0616. 312 567 3613.

The Newberry Library, Special ollections, Map Section, 60 W. alton Street, Chicago, IL 60610. 2 255 3674.

Rand McNally & Co., Map brary, P.O. Box 7600, Chicago, 60680. 847 329 16.

University of Chicago, genstein Library, Map ollection, 1100 E. 57th Street, icago, IL 60637. 773 702 8761.

10. University of Illinois at Chicago, University Library, Map Section, 801 S. Morgan, Chicago, IL 60607. 312 996 2738.

11. Northern Illinois University, Map Library, Room 222 Davis Hall, DeKalb, IL 60115. 815 753 1813.

12. Southern Illinois University at Edwardsville, Lovejoy Library, Social Sciences/Map Library, Edwardsville, IL 62026. 618 692 2632.

13. Northwestern University, University Library, Map Collection, 1935 Sheridan Road, Evanston, IL 60201. 847 491 3130.

14. Western Illinois University, University Map Library, Tillman Hall, Macomb, IL 61455. 309 298 1171.

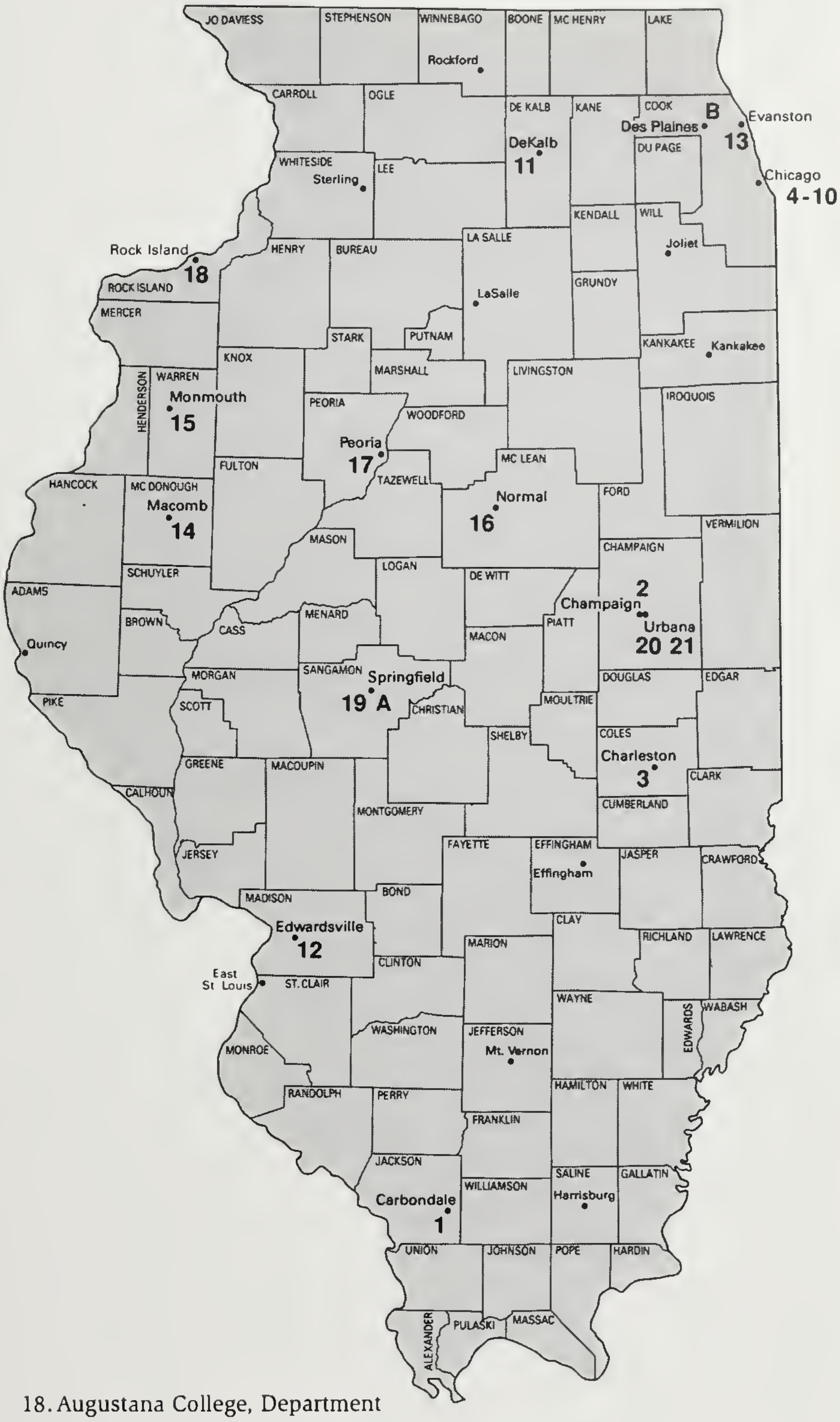
15. Monmouth College, Hewes Library, Monmouth, IL 61462. 309 457 2190.

16. Illinois State University, Milner Library, Map Room, School & College Streets, Normal, IL 61761. 309 438 3486.

17. Peoria Public Library, Business Department, 107 NE Monroe St., Peoria, IL 61602. 309 672 8845.

MAJOR MAP LIBRARIES

(And Reference Libraries of Aerial Photography)



18. Augustana College, Department of Geography, David M. Loring Map Library, Rock Island, IL 61201. 309 794 7318.

19. Illinois State Library, Map Library, 300 S. Second St., Springfield, IL 62701-1796. 217 782 5823.

20. University of Illinois, Geology Library, 1301 W. Green, Urbana, IL 61801. 217 333 1266.

21. University of Illinois, University Library, Map and Geography Library, 1408 West Gregory Drive, Urbana, IL 61801. 217 333 0827.

Sources: (1) David K. Carrington and Richard W. Stephenson, eds. (1985). *Map Collection in the United States and Canada: A Directory*, 4th ed. (New York: Special Libraries Association); (2) David A. Cobb, comp. (1990). *Guide to U.S. Map Resources*, 2d ed. (Chicago and London: American Library Association).

Editor's Note: This list of map libraries is a selection. Corrections and suggestions for additions are invited.